Introduction

The concept "fact" has been a part of European culture and especially English culture for a very long time. Indeed, it has become so much a part of the general furniture of the mind that it has, until quite recently, largely been taken for granted. Every schoolchild has heard of "historical facts" and "scientific facts." "Fact" has played and continues to play a significant role in the natural sciences, the social sciences, historiography, and the news media as well as ordinary speech. It is commonplace to employ distinctions between fact and theory, fact and opinion, fact and fiction, and fact and value.

Historical interest in "fact," perhaps not coincidentally, has developed just at the moment when the concept itself has become increasingly problematic. Philosophers, historians, scientists, and literary critics have questioned and to some extent undermined the conventional wisdom. We hear that "facts" are constructed, that is, "made" by individuals and groups at particular moments in time and place and that what counts as "fact" for one generation may not for another, that one's person's fact is another's fiction, or that there are no differences between factual and fictional narratives. There has been far less recognition that the concept "fact" itself has undergone considerable modification over time and has served a variety of disciplinary enterprises and functions.

My purpose here is to explore part of that evolution by examining the role of "fact" in English intellectual and cultural development during the

early modern period, the period in which it was adopted by a variety of disciplines and was beginning to take on something of its modern meaning. This book continues my explorations of early modern English intellectual life in *Probability and Certainty in Seventeenth-Century England.* It shares that book's concern for the relationships among disciplines and the degree of certainty or probability that could be attributed to "matters of fact." It extends the story of the English legal tradition's contribution to epistemological development and evidentiary traditions. More generally, it examines key conceptual and epistemological concerns that crossed disciplinary boundaries.[1]

My investigations intersect with the innovative work of Steven Shapin and Simon Schaffer on the construction of early modern English empirical natural philosophy, Lorraine Daston's on the history of objectivity and marvels, and Peter Dear's on "experience" and "experiment." These historians of science leave no doubt that "fact" was an important conceptual category for early modern, English natural philosophy. I argue that "fact" does not begin with natural phenomena and was, if anything, a rather late arrival in natural philosophy, having become a well-established concept elsewhere before it was adopted by the community of naturalists.

I begin with law. Although "questions of fact," "questions of law," "mixed questions of fact and law" are standard tools of day-to-day legal analysis, neither legal historians nor legal philosophers have been much drawn to the evolution of the concept "fact" in law. Chapter 1 deals with the nature of "fact" in the European and particularly the English legal context and the characteristic features of fact determination in early modern English common law. Most studies of the epistemological and evidentiary aspects of English law have focused on either the medieval era or the eighteenth century and beyond. Although once almost entirely "internalist" and focused on the evolution of legal doctrine, much legal history has now adopted a "law and society" approach roughly analogous to what historians of science label "externalist." This approach focuses on the function that law plays in society and for the groups or interests it serves. Law and legal doctrine are thus seen as responsive to or reflective of social conditions and socioeconomic interests.[2] My focus on the conceptual framework of legal fact finding may be viewed as more "doctrinal" or "internalist" than "social" but less concerned with disciplinary autonomy than with the development of "fact" in a variety of interdependent institutional contexts.

Beyond such sociolegal writings, legal doctrinal work tends to focus on political issues. With a few notable exceptions early modern legal historians have not attempted to integrate legal concepts and traditions into the general fabric of intellectual and cultural history. We know a good deal about concepts of sovereignty, legitimacy, the state, and property but little

about the truth-finding assumptions and procedures of early modern courts or the relationship between legal and other methods of establishing "truth" or "belief."

Chapter 1 argues that the concept "fact" that emerged in the legal arena helped to shape and sharpen the epistemological assumptions and methods of a wide range of intellectual enterprises and played a key role in the development of English empiricism. In particular I explore the distinctions between "matters of fact" and "matters of law" and discuss early modern legal approaches to ascertaining facts. In this connection I draw attention to the institutional differences between canon and civil law fact finding on the one hand and common law practices on the other, suggesting that the lay participation of common law jurors in fact finding played a significant role in the broad cultural diffusion of the concept of fact.

Subsequent chapters explore how the legally derived concept "fact" and legal methods of establishing "matters of fact" were adopted by other disciplines and intellectual projects and became part and parcel of the generally held habits of thought characteristic of late-seventeenth- and early-eighteenth-century culture.

Chapter 2 focuses on "fact" in history and historiography. Despite the impressive scholarly work on the subject of early modern historiography, there has been little investigation of the role of "fact." This chapter charts the ways in which classical and humanist conceptions of history were modified by contact with legal methods of fact determination, the development of a more document-oriented history, and the study of historical antiquities. I emphasize the evolving distinction between fact and fiction and the norms of truthfulness and impartiality that historians absorbed from both classical historiography and the legal tradition. If early modern historiography remained inextricably tied to rhetoric, it was a rhetoric that came to emphasize "fact," truth, and impartiality, to be suspicious of artfulness, partiality, and ornamented style, and to prefer firsthand witnesses over citations to authority.

Chapters 3 and 4 deal with genres rather than disciplines, genres that describe both human and natural "facts." Chapter 3 investigates travel reporting and chorography, which described places visited, "things" or conditions observed, or events experienced or witnessed. These narratives were linked to history writing and non-narrative descriptions of foreign places, peoples, and objects. They are also related to the support by the English scientific community, and especially the Royal Society, of studies that dealt with natural events and conditions and human customs and practices, that is, with human and natural "facts."

Chapter 4 focuses on the reporting of "news" and "marvels." I attempt to show how the genres associated with "news" adopted "matter of fact" as

their reason for being and employed the conventions of legal and historical fact finding with their emphasis on credible witnesses and particular events. Then as now, news focused on unusual events. If it shared the historiographer's interest in political, diplomatic, and military "facts," early modern news also reported less politically relevant events such as murders, shipwrecks, and robberies. "Marvels" were news. Two-headed calves, earthquakes, floods, and unusual cloud formations became newsworthy "facts." The "news" genres, like the chorographic and travel genres, played a role in transforming "fact" from a category limited to human actions and deeds into one that comprehended both human and natural phenomena. In the process these "discourses of fact" adopted from law and history their norms of impartiality and fidelity and their emphasis on firsthand credible witnessing. These two chapters suggest the broadening conceptual and cultural domains of "fact."

The next two chapters focus directly on the development of the "scientific" or "natural" fact. Chapter 5 traces the development of "fact" as a constituent part of the new natural history. This chapter argues that in the early seventeenth century the concept "matters of fact" and the procedures for proving them were well established in law and history before they were adopted in natural philosophy. The lawyer, historian, and natural philosopher Francis Bacon played an important role in their transfer to the natural philosophical and experimental community of the following generation. Legal notions were adopted and adapted by the English scientific community and particularly in the Royal Society's emphasis on "fact" in natural history. I take up the Baconian emphasis on experiment, the connection between "fact" and the new-style natural history, the nature of scientific witnessing, and the role of observational aids such as the telescope and microscope. The conditions of scientific investigation, experiment, and decision making in some ways resembled and in others differed from those of the law court. This chapter explores how the institutions, processes, and participants in fact finding and fact making in various disciplines altered the nature of the fact-finding process to meet their own particular needs. Witnessing and credibility are given extended treatment. Some attention is paid to "fact" in the work of Continental naturalists and experimenters in order to better assess the degree to which the centrality of "matter of fact" in seventeenth-century natural investigation should be treated primarily or initially as an English development.

Chapter 6 is devoted to three specific aspects of the development of fact in natural philosophy. The first is the role of gentlemanly and aristocratic values of trust and mutual respect in establishing a scientific culture of fact hypothesized by Steven Shapin and Simon Schaffer. While I view the evidence from the naturalist community itself as showing more concern for observational opportunity and expertise than gentility, my major point is

a different one. The mode of establishing scientific matters of fact practiced by the virtuosi is not a peculiar feature of the "gentlemen" of the Royal Society but instead is part of a culture of fact developed earlier and simultaneously in other disciplines as well, especially law. Lawyers and virtuosi shared an emphasis on truth, an insistence on fact over fiction and imagination, a preference for firsthand and credible witnessing, and a rhetoric of impartiality. The courtroom and the rooms of the Royal Society shared a great deal, and whatever the courtroom was, it was certainly not a place of shared, gentlemanly trust.

The second part of this chapter explores the relationship between "fact" and causal explanations involving "principles," "hypotheses," "conjecture," "theory," and the "laws of nature." It compares these efforts in natural philosophy with the historians' and newsmen's use of "conjecture," "reflection," and "inference."

Finally, this chapter examines the mode of discourse practiced in English natural history and natural philosophy. The rhetoric and stylistic norms advertised by the Royal Society and its members were actually common to all the discourses of fact. In the context of other changes in rhetoric and developments in religious epistemology, it becomes clear that the development of the polite, "gentle," noncontentious modes of discourse of the virtuosi was at least in part promoted by the epistemological implications of the concepts of fact they employed rather than by their social position or aspiration.

Chapter 7 attempts to show how the concept "fact" and essentially legalistic approaches to proofs for "matters of fact" were adopted by a variety of post-Restoration religious controversialists. In this context, "fact" is used to support "belief" in principles of natural theology and key portions of the Bible, to argue against Roman Catholic claims, to prove the existence of spirit, and to underpin ecclesiastical history. I argue that the successful deployment of the proofs of matter of fact in the sphere of religion played an important role in making "fact" a central cultural category. As Protestant Christianity came to rely on arguments from matter of fact to establish and support belief in the central tenets of Scripture, "fact" came to have a more and more central role in English thinking and culture.

The final substantive chapter deals with the elaboration and diffusion of "fact" in English culture. It begins with Locke's role in elevating fact into a generally applicable philosophical category no longer tied to particular disciplines. By the early eighteenth century we can begin to speak of England as participating in a general "culture of fact." We look beyond 1700, if only briefly, to suggest something of the continuing evolution and importance of "fact," which became deeply embedded in eighteenth-century British philosophy, itself much taken with the continuing legal writing on fact. This chapter also reviews the relationship between "fact" and

"fiction," suggesting how changes in this relationship made it possible for the conventions of reporting "matters of fact" to shape the fictional genres of the late seventeenth and early eighteenth centuries. "Fact" became incorporated in a new kind of fiction, the "fictional facts" of the early novel.

The conclusion provides a summary and suggests how this study fits into existing traditions of intellectual and cultural history.

It is necessary to say a few words about chronology, terminology, and categories. The chronological span suggested by the title needs some comment since my treatment of the various disciplines is not identical. The law and history chapters focus on the sixteenth and early seventeenth centuries because developments dealing with "human" facts precede and help shape those that deal with "natural" facts. The chapters dealing with mixed modes of human and natural facts and those dealing with natural facts emphasize the second half of the seventeenth century. The adoption of arguments from "fact" by religious polemicists being on the whole a rather late development, the religious chapter is largely concerned with the late seventeenth century. The penultimate chapter on cultural elaboration, which refers to a number of disciplines and genres, carries the discussion into the eighteenth century and is meant to point the way to further research. Although a main theme of this book is the interrelatedness of the various discourses of fact, I have organized chapters roughly along modern lines of law, history, science, and religion, an organizational format that makes it possible to chart cultural connections *and* disciplinary development.

Some new work by historians of science views natural philosophy as a category that encompassed much of both "science" and "religion" and also excluded parts of each. I draw attention to these revisionary efforts but retain the more traditional categories, in part because a firmly agreed recategorization scheme has not yet emerged and in part because however much natural philosophy may have concerned itself with Divine creation, there were still broad streams of religious and naturalist endeavors and writings that were and were perceived at the time to be relatively distinct.

Current and early modern terminologies do not always convey the same meaning, and the early modern usages were themselves somewhat confusing. I occasionally use the terms "science," "scientist," and "scientific fact," but these terms are anachronistic. I sometimes use "naturalist," a term that includes both natural historians and natural philosophers. Certainly "science" and "scientists" would not have made sense to early modern practitioners of "natural history" and "natural philosophy." Natural history involved the description of particular empirical phenomena and covered a much broader range of inquiries than is implied by our modern "natural history." Natural philosophy treated of causes and principles that

often included some we think of as theological. The same persons were frequently engaged in both natural history and natural philosophy and often were referred to as "experimental philosophers," "new philosophers," or "virtuosi." "Scientist" now carries the suggestion of a professionalism that did not exist then. I sometimes use the term "virtuosi," though it may connote either amateurism or virtuosity. The word "science" itself was employed then in several different ways, ranging from any body of knowledge or skills to what today we would call a discipline, and implied a level of certainty that few natural philosophers would claim. In the seventeenth century natural philosophy included the nature of the deity and his Creation, and there were "civil," "natural," "ecclesiastical," and "divine" histories.

Although at times I point to related Continental developments and in some instances to the need for a comparative perspective, this study is focused on early modern English developments and English cultural venues. Although limited in time and space and in what aspects it considers of the various disciplines it explores, this book traces how the concept "fact" became a central feature of several intellectual enterprises and of the general English intellectual landscape. I describe a widening circle of influence from law that with time extended to historiography, news, marvels, the study of natural phenomena, religion, and the pseudohistory and pseudobiography we call the novel. As it is adopted by different intellectual enterprises with different problems to solve, "fact" may come to have different functions and different roles in the different disciplines. As it moves from one discipline to another, "fact" is transformed in many ways—but a common core of meaning persists that becomes central to English culture.

CHAPTER ONE

"Fact" and the Law

The concept of "fact" took shape, I have suggested, in the legal arena and was then carried into other intellectual endeavors until it became part and parcel of the generally held habits of thought of late-seventeenth- and early-eighteenth-century English culture. So now we must turn to that legal arena.

Although my focus is primarily on England and English culture, examination of the English legal tradition of fact finding cannot be limited to the common law. Despite its frequent claims to uniqueness, the common law drew on the Romano-canon legal tradition. The English were constantly exposed to that tradition and its variants in Chancery, Admiralty, and the ecclesiastical and prerogative courts. Civil law learning informs many of the authoritative sources of the common law, most notably Bracton. The Romano-canon tradition, formalized earlier than English common law, had developed a complex evidentiary system during the Middle Ages. The ordeals and other irrational proofs were replaced by rational inquiry and the critical sifting and evaluation of the available evidence by professional judges. Witnesses played a central role in the rationalization of evidence, perhaps the single most important change in later medieval law.[1] The system quickly developed into one of written depositions in answer to written interrogatories prepared by legal professionals. Complex rules established the credibility of witnesses and excluded incompetent, biased, or interested testimony. In serious criminal offenses for which the

evidence of two good witnesses or the confession necessary for "full proof" was lacking, the testimony of less credible witnesses, a single witness, or other *indicia* or signs were sufficient to order judicial torture of the defendant to elicit the confession that would constitute full proof. Drawn from the ancient rhetorical tradition, these *indicia* included the age, sex, education, social status, and reputation of the individual in question. Similar criteria were invoked in assessing witness credibility and circumstantial evidence.[2]

The Romano-canon system distinguished between fact and law, a distinction embodied in the civil law proverb "You give me the facts, I give you the law" and in the numerous procedural manuals that developed from the twelfth century onward.[3] "Fact" or "factum" in law implied human actions or events in which human beings participated that might be known even if not directly observed at the time of adjudication. Typically, they were actions, such as a murder or a robbery, that had been committed some time in the past. The "facts," which were to be established by both written documents and witness testimony, provided the basis for belief and judgment. The distinction between matters of fact and matters of law was found in the law of all jurisdictions that derived all or part of their law from the civil law that had developed in Italy and elsewhere during the medieval era.[4]

Some, but not all, of this legal technology was also to be found in the English common law. Three somewhat related features of the common law system are particularly relevant to our inquiry. The first is the legal usage of "fact" and the distinction between "matters of fact" and "matters of law." The second is the development of lay jurors as fact evaluators, particularly of witness testimony. The third is the value the legal system placed on impartial public proceedings and unbiased judgment.[5]

"Matter of Fact" and "Matter of Law"

Unlike the Romano-canon law, the common law separated the determinations of "matters of fact" from "matters of law" institutionally, placing the former in the hands of lay jurors and the latter in the hands of professional judges. One of the most important results for our purposes is that experience with "facts" and fact determination became familiar to that quite substantial group of ordinary individuals eligible to serve on juries.[6] English self-congratulation on the jury of "twelve good men and true" helped enhance the sense of jury fitness to undertake its fact-finding task. The quite widespread experience and familiarity with legal institutions and the language of fact and methods of fact determination thus brought facts easily to the attention of the English so that they became part of the "furniture of the mind." I suggest that it was precisely this familiar-

ity and this confidence in juries that made "fact" so easily transportable to a variety of nonlegal contexts.

The term "fact" as used in English law had two related meanings. The first, and more general, referred to any human act or deed of legal significance that had, or would, take place. In the second, "fact" referred to the act constituting the crime of which the defendant stood accused. The act, the fact, thus required proof. A judge demanded that "Evidence be given of the truth of the Fact, that Gentleman did murder himself is this."[7] The "fact" in question might be an act that occurred on a particular occasion, for example, "the evening of the fact," or a series of acts such as adultery or treason that might take place over some time. A prisoner who pled not guilty "denieth the fact." The accused had been "taken in the Fact" of arson. We also find references to the "Heinousness of the Fact" and to "malefactors" and the still common legal usage "before the fact" and "after the fact."[8] William Lambarde's popular *Eirenarcha* employed similar categories, categories also to be found both in Cicero's *De inventione* and the *Rhetorica ad herennium*. Lambarde's "precedent" category, analogous to "before the fact," included the "will to do the fact" as well as the "power to commit the act." In dealing with the "present" category, justices of the peace were to consider whether the accused had been present at the fact and conditions in the absence of which "the fact could not follow." "Subsequent" acts are "after the fact."[9] The language of fact as act or deed, particularly of a criminal nature, became familiar English usage.

Although the origin of the distinction between matter of fact and matter of law in English law remains unclear, it was well known in the sixteenth century.[10] The Latin maxim *ad quaestionem facti non respondent judices, ad quaestionem juris non respondent juratores* was much quoted by Coke, who attributed it, perhaps incorrectly, to Bracton.[11] The first example of the distinction between matters of fact and matters of law in English I have encountered is Sir Thomas More's *Debellacyon of Salem and Bizance* (1533). Here the terms are employed in ways suggesting common use and widespread understanding rather than innovation. More, whose work was written for a fairly broad audience, was attacking Christopher St. Germain's *Salem and Bizance*, which examined procedural and evidentiary differences between English ecclesiastical courts in cases of heresy and the common law courts in cases of felony. The distinction between fact and law is employed by both More and St. Germain as they discuss the nature of witnesses, assessments of their credibility, and the perjury of witnesses in heresy trials. Both also clearly distinguish jurors from witnesses and insist that in common law trials jurors are "judges of the fact." In this instance, as in so many others, the distinction between fact and law is employed in the context of distinguishing the work of the judge from that of the jury.[12]

From the sixteenth century, if not earlier, jurors were seen as "judges of

the fact." Statements to that effect appeared with some regularity in judicial charges to the jury and in judicial summing-up of evidence. Jurors and others who attended or heard about criminal trials would have been familiar with the idea that juries were assigned the task of determining whether the "fact" alleged in the case was to be considered proved. "Fact" in this context implied a human deed or action which had occurred in the past and which had to be substantiated or proved to the satisfaction of the jurors, who were "judges of the fact." The "fact" or "matter of fact" was not considered "true" or suitable to be believed until satisfactory evidence had been presented. A "matter of fact" was an *issue* placed before a jury as to whether a particular person had performed a particular act or set of acts. "Fact" in the legal context therefore did not mean an established truth but an alleged act whose occurrence was in contention.

Although there are relatively few records of early-seventeenth-century trials, the charge of the attorney general in the notorious case of the earl of Somerset, accused of poisoning Sir Thomas Overbury, uses the language of fact in the typical legal sense. Here the fact in question is murder, and the fact is distinguished from the evidence that would establish the fact. The prosecution, which first made "a Narrative or Declaration of the Fact itself," then promised to "Break and distribute the Proofs," consisting of "witnesses," "examinations," and various writings.[13]

The best-known jurist of the late Elizabethan and early Stuart era, Sir Edward Coke, insisted that judges in the common law courts were not to answer questions of fact, nor were juries to answer questions of law, but that in Chancery judges would decide fact questions on the basis of the depositions of witnesses. Witness testimony in common law trials was "but evidence to a jury," and juries were sworn "to inquire of the matter of fact." Giles Duncombe characterized the jury as "sworn Judges in matter of fact, evidenced by witnesses and debated before them." He insisted that the public nature of English trials meant that "the Fact is settled, with greater certainty of truth" in English courts than elsewhere. It was common knowledge that the office of the jury was to find the truth of the facts; that of the judge, to declare "veritatem juris."[14] In practice the convention of facts for the jury and law for the judge was not always rigorously followed. Occasionally, there were claims that jurors were properly judges of law as well as of fact.[15]

Juries

Jurors were not initially fact evaluators but rather "knowers" of the facts, selected locally because they were expected to bring some prior knowledge of the facts and/or the litigants to the trial. Witness testimony to establish facts began in the fourteenth or fifteenth century but seems to

have become a regular and accepted part of common law proceedings only in the course of the sixteenth century. Thomas More and Christopher St. Germain treated the proposition that jurors were not witnesses but judges of fact as if it were common knowledge.[16] Soon legislation attempted to ensure that suspects and witnesses would appear in court. Subpoena procedures developed, and perjury made a statutory crime. The justices of the peace were active in the pretrial examination of witnesses in the mid-sixteenth century. As witnesses became more common, the courts more clearly distinguished not only between jurors and witnesses but between witnesses and accusers. A kind of cross-examination of witnesses by counsel during trial became possible.[17] In the early seventeenth century Sir Edward Coke insisted juries were to be led to their verdicts by the witness testimony they heard in court, and Sir Francis Bacon, then Lord Chancellor, indicated that the law of England "leaveth the discerning and credit of testimony wholly to the juries' consciences and understanding."[18] Jurors in both civil and criminal cases were required to determine the truth or falsity of the evidence presented to the court. Although jurors legally retained the right to personally know the facts at issue, they were, for all practical purposes, limited to evaluating the documentary and parole evidence presented to them.[19]

Matters of fact in most situations were to be proved either by the testimony of witnesses or by "authentic" documents. Legal and other dictionaries thus distinguished between "matters of deed" and "matters of record." In civil cases there was a strong belief that written records were superior to witness testimony because they were not subject to the fallibility of human memory.[20] In criminal cases the testimony of witnesses was central.

Assumptions and Epistemological Issues

Although law as a discipline is typically approached as a matter of normative rather than empirical inquiry, in everyday legal practice questions of empirical epistemology necessarily arise. Once witness testimony became central to English legal proceedings, how the jurors are to discern the truth of the facts alleged in court became an important practical question. Early modern common law courts, however, are rather difficult to analyze sharply in epistemological terms because they are a combination of institutional elements and procedures. Some, like the jury, had been created in the distant past. Others, like the witness, were a more recent innovation. Because the common law trial combined lay and professional elements, it incorporated both lay and professional epistemological assumptions and patterns of thought. In the process of attempting to cope with current social and political contexts and with changing patterns of

belief about how judgments should be made, the common law courts developed an evolving set of rules about evidence. For instance, early modern courts retained the older device of oaths, grounded in earlier epistemological beliefs but also reinforced by Reformation concerns with conscience. The relationship between the old oaths and the developing rational criteria for assessing witnesses was unclear. This tension was important because at that time only some parties and some witnesses could testify under oath.

A number of assumptions underlay the modes of inquiry of early modern courts. The first was that it was possible to gain adequate if not perfect knowledge of events that could not be seen, heard, or repeated in court. Neither judges, jurors, nor lawyers would actually "see" the killing or the land transaction at issue. The law dealt with "transient things" of no "constant being." Firsthand sensory experience might provide "best evidence" for "matters of fact," but it was unattainable by courts. Courts therefore relied on documents that recorded the actions or rights in question or on witnesses who had seen or heard the events in question. If courts were to employ witnesses, their testimony had to be believable and trustworthy. It was necessary to develop some way of thinking about which kinds of testimony were likely to be credible and which were not. There was an awareness that owing to the "imperfection of memory," the "rembrance of things fails and goes off" and men were likely to "entertain opinions in their stead."[21]

All early modern courts were dependent on testimony. Common, civil, and canon law developed rules of exclusion and evaluation, the second two more rule-bound than common law courts, where jurors assessed credibility and determined whether the "matter of fact" had been adequately proved. Legal procedures assumed jurors had sufficient intellectual ability and moral probity to assess witness credibility adequately and to reach verdicts of sufficient certitude to satisfy their consciences and the community at large. The law adopted an epistemology that put great faith both in witness observers and in jurors as "judges of fact." The common law courts provided a critical site for inquiry about facts.

Witness Competence

If decisions about credibility were made by juries, competency to testify was determined by the judge. Those guilty of certain crimes—for example, treason, felony, and *crimen falsi* such as perjury and forgery—were excluded, their oaths being "of no weight." Madmen, idiots, and children were excluded for "want of skill and discernment."[22] In civil cases those with a pecuniary interest were excluded from testifying.[23] There was controversy about accused co-conspirators, co-defendants, and acces-

sories who were most likely to have firsthand knowledge of the fact but also likely to lie. On the whole, such witnesses were treated as competent, leaving "it to the Jury what to believe."[24] Similar treatment was given to the testimony of those who had been convicted of a crime and later pardoned.[25]

Witness Credibility

Determination of witness credibility became central to the early modern trial, though technically decisions might be reached without any witnesses at all. Sir Francis Bacon, early in the seventeenth century, and Hale toward the end of it agreed that the law of England left "the discerning and credit of testimony wholly to the juries' consciences and understanding." As Hale put it, "It is one thing whether a witness be admissible to be heard, another thing, whether they are to be believed when heard." Jurors were "judges of the fact, and likewise of the probability or improbability, credibility or incredibility of the witnesses and the testimony."[26]

There is, however little judicial writing on how such assessments should be made. It sometimes was asserted that witnesses should be considered "honeste, good and indifferent, till the contrary be shown," a view still echoed by Gilbert two centuries later.[27] Clearly, gender, property holding, social status, education, and expertise were part of the equation, as was the oath taken by witnesses and whether or not the testimony was hearsay. Juries were to judge the "Quality, Carriage, Age, Condition, Education and Place of Commorance of Witnesses" in giving "more or less Credit to their Testimony."[28]

The widely distributed manuals for justices of the peace contained credibility criteria to assist the justices in examining witnesses and persons accused of felonies. We do not know to what extent these manuals either echoed or were incorporated into jury instructions, although some of the "better sort" of jurors might have read them or heard them discussed before jury service.[29] William Lambarde's popular late-sixteenth-century handbook suggested that in the course of pretrial examinations justices of the peace must consider ancestry, education, occupation, and character. Post-1618 editions of Dalton's *Country Justice* added "two old verses" derived from the Romano-canon tradition indicating that those who examined witnesses should consider

> Conditio, sexus, aetas, discretio, fama,
> Et fortuna, fides: in testibus esta requires.[30]

The causes of suspicion, which resonated to Romano-canon law, were also to be found in Thomas Wilson's Ciceronian *Art of Rhetorique* (1553). Many of the same criteria were employed in assessing the guilt of the accused.[31]

The manuals for the justices of the peace, with their criteria for "suspicion" echoing both the Romano-canon tradition and English legal practice relating to arrest and pretrial examination, became absorbed into the general law and culture of evidence.[32] Gilbert's authoritative treatise on evidence, which summarized the practice of the early eighteenth century, thus indicated that there were a number of things that might "render a witness suspected." A party to a crime or one who swore "for his own safety or indemnity, or be a relation or friend to the party, or the like; or be of a profligate or wicked temper or disposition; and the weight of the probability lies thus; if you think the bias is so strong upon him, as would incline a man of his disposition, figure and rank in the world, to falsify, you are to disbelieve him; but if you think him a man of that credit and veracity, that, notwithstanding the bias upon him, would yet maintain a value for truth, and is under the force and obligation of his oath, he is to be believed."[33]

Hearsay Testimony

The formal exclusion of hearsay was a rather late development in English law, probably because of the late and rather gradual arrival of witnesses and of jurors as fact evaluators. Although hearsay was a familiar concept and hearsay evidence was clearly viewed as inferior, it does not appear to have been rigorously excluded until the mid-eighteenth century.[34] Quintilian's *Institutes of the Orator*, studied by schoolboys from the sixteenth century onward, examined how hearsay testimony could be used by the orator as a means of strengthening and undermining arguments. Polybius's critique of hearsay too was well known. Secondhand testimony was considered far less valuable than that received "from those that report of their own view." This statement by Hale is echoed by Lord Chief Justice Holt, who indicated in a 1691 case that witnesses had not presented "Evidence: unless they testified what they themselves knew or had heard from the accused." By the time Locke wrote at the end of the seventeenth century, it was already a truism "that any testimony, the further off it is from the original truth, the less force and proof it has. . . . A credible man vouching his knowledge of it is a good proof; but if another equally credible do witness it from his report, the Testimony is weaker, and the third that attests the hearsay of a hearsay is yet less considerable."[35]

Hearsay was clearly permissible under some circumstances. The principle that hearsay might be used to confirm or corroborate other testimony was employed in Raleigh's trial of 1603. In the early eighteenth century Gilbert wrote that "mere hearsay . . . may in corroboration of a witnesses' testimony, . . . shew that he affirmed the same thing before on other occasions, and that the witness is still consistent with himself."[36] The uncertain treatment of hearsay in the seventeenth and eighteenth centuries, and indeed in the twentieth, reflects the perennial epistemological

question whether poor evidence is better than no evidence. Indeed, hearsay is one of the few points at which legal theorists and historians confront problems of empirical knowing.

Indicia of Credibility

On the whole, women's testimony was probably trusted less than men's. The lesser value of women's testimony was embodied in the civil law. Although English women appeared as witnesses, they did not serve on juries.

A child's testimony was viewed as less credible than that of an adult, and the testimony of children under fourteen was generally excluded. The weak of mind and the insane too could not testify, for they like children lacked "skill and discernment."[37]

Reputation was also a factor in assessing witness credibility. Here again we can see a kind of translation from the justicing handbook directives concerning "suspicion" in pretrial examination to the criteria for jury assessment of witnesses. Only a generation or so after Lambarde and Dalton, Judges Hale and North echoed their criteria. North in particular mentioned the "inclinations" and the "education" of the witnesses. Those who have "habits of falshood and are Comon & Known lyars" and those who lived "open, vitious scandalous lives" could be heard in court, but their testimony could bind jurors "no farther" than they believed it in their conscience to be true.[38]

In criminal trials defendants often attempted to show that government witnesses were persons of low moral character, of "ill fame," or lacking in integrity. Thomas More, on trial for treason, attempted to show that Richard Rich had been notorious as a "common lyar" and a man of "no recommendable fame."[39] Cynthia Herrup's study of seventeenth-century criminal process also indicates that a reputation for good moral character substantially affected legal outcomes. The Popish Plot trials of the late seventeenth century often emphasized the low moral status and lack of integrity of crown witnesses. As Thomas Hobbes stated succinctly, the evaluation of testimony involved two considerations: "one of the saying of the man; the other of his virtue."[40]

Moral status and reputation blended into but were not identical to social and economic status. In the courtroom as elsewhere the testimony of independent property holders counted for more than that of dependents or the poor. We have noted references to "Quality" and "Condition" that first appeared in the justicing handbooks and reappeared in Hale's treatment of credible witnesses. In some instances the interests of servants were assumed to be that of their master, a situation roughly analogous to that of wives, whose interests were assumed to be identical to their husbands', and were thus seen as having "unity of persons."[41]

Assumptions about reliable testimony corresponded in a rough way to the existing social hierarchy in which noblemen and gentlemen were ranked above yeomen and merchants, and yeomen and merchants above poor husbandmen, servants, and the unemployed. But status considerations might be countered by others. As we noted earlier, those with a pecuniary interest were entirely excluded from testifying in civil cases regardless of status and wealth.

Religion played a role in assessing credibility of witnesses in a number of ways. One's reputation for piety was a relevant consideration, and those who were "atheistical and loose to oaths" were not to be given the same credit "as men of good manners and clear conversation."[42] Despite hostility to Roman Catholicism, the testimony of Roman Catholics was considered credible, at least in cases where religion was not involved.[43] In one of the Popish Plot trials, however, one judge indicated that slender credit should be given Catholic testimony in a "Papist Cause, and for a Papist."[44] In practice, questions of religion or irreligion shade into general questions of the moral character of witnesses or the issue of testimony under oath.

Jury consideration of the "quality and qualifications of witnesses" included the "manner of their Testimony." "Many times the Manner of a Witnesses's delivering his Testimony" provided "a probable indication whether he speaks truly or falsely."[45] Hale and others often stated that they preferred the English over the Continental process because of the superior opportunity to assess witness demeanor. Demeanor became a standard element in the evidentiary tradition: "An over-forward and hasty zeal on the part of the witness, . . . his exaggeration of circumstances, his reluctance in giving adverse evidence, his slowness in answering, his evasive replies, his affection of not hearing or not understanding the question . . . precipitancy in answering . . . his inability to detail any circumstances wherein, if his testimony were untrue, he would be open to contradiction, . . . are all to a greater or less extent obvious marks of insincerity."[46]

PREUSSISCHER STAATSBESITZ BIBLIOTHEK ZU BERLIN KULTURBESITZ

Expertise and Experts

Although expert witnesses are commonly found in the modern courtroom, they were less common in earlier centuries. In most matters the testimony of ordinary individuals was considered reliable. Yet expertise counted for something: "Discernment must arise from the skill, and will appear from the reasons and accounts they give of their knowledge." Those that give more "plain and evident marks of their knowledge" were thus deemed more credible.[47] These statements, however, seem to refer to greater experience and knowledge rather than to professional expertise.

Expert witnesses sometimes testified, though we know relatively little about their use and legal status. Physicians often testified in cases involving poisoning and witchcraft, and midwives in cases of infanticide or rape.[48]

Something akin to expert testimony also seems to come into play in cases involving the testimony of merchants on what constituted accepted and normal practice.

Multiple Witnesses

Unlike Continental and ecclesiastical courts, the English were not bound by the two-witness rule. English courts could reach verdicts without any witnesses at all. Hale and Locke state the normal preference for multiple witnesses, but numbers were not necessarily decisive. Refusals to indict or convict might occur in the face of the testimony of twenty or more witnesses.[49]

A recent study focusing on oaths suggests that the number of witnesses testifying on oath made a crucial difference and that credibility considerations counted for little.[50] This finding runs counter to all the contemporary statements concerning credibility assessments we have encountered. If it were correct, there would have been little point to a trial. Jurors would have just counted the number of witnesses testifying under oath and given their verdict. Yet Hale insisted that juries were entitled to "disbelieve what a Witness swear" and "may sometimes give Credit to one Witness, tho' opposed by more than one." One of the "Excellencies" of the jury trial was that the jury "upon Reasonable Circumstances, indicating a Blemish upon their credibility," might pronounce a "Verdict contrary to such Testimonies, the Truth where of they have just Cause to suspect, and may and do often pronounce their Verdict upon one single Testimony."[51]

Certainly the number of concurrent testimonies was thought to increase probability and make the evidence "more concludent." Gilbert would write, "The first and lowest proof is the oath of one witness only." A single witness required "great confidence in the integrity and veracity of the man." The testimony of two oaths was "higher" because, if they agreed "in every circumstance," they must be either "perjured or telling the truth."[52]

There were traces of the biblically derived two-witness rule in England. In treason cases the two-witness rule was often voiced, though the various treason statutes of the early modern period sometimes included it and sometimes did not until it was made permanent in 1696.[53] The two-witness rule is also to be found in connection with perjury. The still current requirement that wills be witnessed by two witnesses can be explained by the fact that until well into the nineteenth century wills were under the jurisdiction of the ecclesiastical courts.

Incredibility of the Fact

Prevailing common-sense beliefs also bore on questions of credibility. Francis North, Lord Guilford, chief justice of Common Pleas, indi-

cated that the "Probability of [th]e Matter" was involved in assessing witness credibility.[54] The incredibility of the fact "overthrows" the testimony of a witness and "set[s] aside" his credit: "For if the fact be contrary to all manner of experience and observation," it was "too much" to receive on the oath of a single witness.[55] Multiple witnessing of incredible events, however, was more difficult to reject because the credibility of biblical miracles was defended on the basis of multiple witnesses.

Witchcraft provides an interesting example of a "fact" whose general credibility eroded over time. It came to be thought impossible by the majority of educated persons by the beginning of the eighteenth century. Although belief in witchcraft persisted among the uneducated, a 1712 jury acquitted the accused despite the testimony of numerous witnesses.

Contradiction and Consistency

Inconsistency of a witness "removes him from all credit, for things totally opposite cannot be believed from the attestation of any man." Enunciated by Gilbert in the early eighteenth century, this position had a long history. St. Germain expressed a similar view in the early sixteenth century. On discovering contradictions, juries were entitled to assume "lyghtness of mynde, hatred or corruption of money."[56] Justicing handbooks too indicated that if the tales of two persons varied, neither was to be credited. In a 1671 case a judge pointed out that the contradictions between the testimony of two witnesses "took off their Whole Testimony." Hale argued that when jurors could directly observe contradictory testimony, "great Opportunities" arose to gain "the true and clear Discovery of the Truth." Among elements for evaluating witness testimony, Locke too listed "the consistency of the parts, and circumstances of the relation" as well as "contrary testimonies."[57]

Cross-examination of witnesses by counsel as we currently know it did not exist in criminal cases. Something like it probably did in civil cases where both parties were represented by counsel. Even in criminal trials Hale noted that the jury, the parties, their counsel, and the judge could "propound occasional Questions, which beats and boults out the Truth." Oral questioning, he thought, was "the best Method of searching and sifting out the Truth."[58]

Oaths

The oath was a important feature of the early modern courtroom and was a part of legal proceedings long before rational approaches to fact finding came into being. Oaths predated the introduction of witnesses to the common law trial, and Anglo-Saxon oaths already invoked the language of fidelity and credibility that would later become hallmarks of wit-

nesses. Although oaths had a longer history in the canon and civil law courts, the administration of oaths to witnesses must have been a relatively late addition to the common law trial. Witnesses swore to tell "the whole truth and nothing but the truth as near as God shall give you grace."[59] Yet it was obvious that both parties and witnesses might lie or fail to report all they knew of the facts. Writing at a time when witnesses were still relatively new to the common law trial, Thomas More noted that witnesses "myght swere false."[60] Perjury became a statutory crime during the same period in which witness testimony became routine.[61] The numerous discussions of credibility we have been examining do not suggest that credibility issues disappeared for testimony given under oath.[62] At most, it was probably true as Gilbert said that the law begins with the "benign and human" presumption that witnesses do "not falsify or prevaricate."[63]

In civil trials witnesses for both parties testified on oath. In such cases jurors were very likely to have heard conflicting testimony and could not have believed all the witnesses simply because they testified on oath. As noted earlier, it may be in practice that under such circumstances juries merely counted, but if so their practice ran counter to much contemporary scholarly and judicial commentary on credibility.[64] The situation was more complicated in criminal trials, where only prosecution witnesses testified on oath. The question here was whether those who testified under oath were automatically considered more credible than those who did not. Hale tells us that things "may blemish the credibility" of sworn testimony and that credibility assessments were left to the jury, "who are judges of the fact, and likewise of the probability or improbability of the witness and his testimony." "It is one thing, whether a witness be admissible to be heard, another thing, whether they are to be believed when heard." Judge North, Lord Guilford indicated that juries had "great Latitude" and "may say they beleev or doe not beleeve in any Case, & concerning any Witnesses." If juries were to evaluate credibility as Hale, North, and even Gilbert clearly suggest, what are we then to make of Gilbert's statement citing Coke that "every plain and honest man affirming the truth of any matter under the sanction and solemnities of an oath, is entitled to faith and credit"?[65] The actual relationship between the oath and the jury's duty to assess witness credibility remains problematic. Seventeenth-century juries probably received instructions looking both ways. Since prosecution witnesses testified under oath and the defendant and his witnesses could not, most cases would have left nothing for juries to decide if sworn testimony had been taken at face value. Yet we know that juries did acquit.

The tension between credibility and oath became especially apparent during the politically charged Popish Plot and Exclusion trial. Prosecutors asked jurors to believe Crown witnesses simply because they testified on oath. The defense insisted that jurors weigh the credibility of those wit-

nesses.[66] The matter was further complicated by the fact that in these cases accessories were often witnesses for the prosecution and so were not entirely believable unless the oath itself made their testimony credible. Judges not infrequently insisted that such persons, though legally competent to testify and thus eligible to take the oath, were to be judged as to credibility by the jurors. Juries were "triers of the credit of the witnesses as well as the truth of the fact."[67]

There was some interest in reforming oaths in the latter half of the seventeenth century. William Petty, a leading member of the Royal Society, turned his attention to "preventing the Abuse of Oathes and Ascertaining Testimony" in the courts.[68] Beginning in 1696 defense witnesses in treason cases were permitted to testify under oath, and this privilege was extended in 1707 to all felonies. Such reforms presupposed that juries would deal with the credibility of sworn testimony because otherwise they would have reached an impasse in cases in which there was sworn testimony on both sides.

Oaths—Juries

Jurors took an oath to "truly try and true deliverance" give and to produce "a true verdict" according to the evidence.[69] Distinct oaths for witnesses and jurors underline the fact that their functions had become distinct, although we do not know when separate oaths first began to be administered.

Jurors sometimes produced verdicts obviously against their oaths and against the evidence. Jury nullification, that is, a verdict against the evidence, was an obvious violation of the juror's oath, as was the gross undervaluation of stolen goods employed to reduce a capital crime to a less serious one. Such acts of mercy, often undertaken with the complicity of the judge, suggest that oaths were not always taken literally and that jurors in such instances did not anticipate divine retribution. Grand jurors too ignored their oaths when they failed to present offenders. Despite the alleged fear of divine sanction, it was commonplace for witnesses, jurors, and grand jurors to violate oaths, however much the clergy might inveigh against the practice.

Circumstances

Circumstantial evidence sometimes played a substantial role in criminal cases where direct evidence, that is, eyewitness testimony, was unavailable, such as prosecutions for forgery, witchcraft, rape, and poisoning. Its inferior status was assumed by the legal community at large. Following the language of the canonists and civilians, Coke and later English

writers characterized circumstantial evidence and presumptions as "light," "temeria" (sometimes called "probable"), and "vehement" (sometimes "violent"). Only the third category was appropriate to support a conviction.[70] In one case a judge informed the jury its decision was to be made on "Evidence and the Circumstances." In another the King's Counsel spoke of a "concurrence of Evidence and other Circumstances." In still another it was pointed out that conviction for treason required two positive witnesses and corroboration "too by very many strong Circumstances."[71]

Yet circumstances and the presumptions they engendered were not "fact." Gilbert wrote that even violent and probable presumptions "non est Factum." "When the fact itself cannot be proved, that which comes nearest to the proof of the fact is, the proof of the circumstances that necessarily and usually attend such facts." "Presumptions" stood "instead of the proofs of the fact till the contrary be proved."[72]

Jurors were given little instruction as to what constituted "circumstances" and presumptions other than the ancient maxim that a bloody sword constituted a violent presumption of murder. Jurors might be told that circumstances did not include their own "private Opinions," "public fame," "common report," or "Verdicts in other Cases,"[73] but often not much more. Two distinguishable forms of evidence, testimony as to facts and "circumstances" under appropriate conditions, constituted sufficient proof to support a verdict.

Verdicts

Although we know even less about how early modern juries actually reached their verdicts than we do about modern ones, we know a good deal about standards for verdicts, at least in criminal cases, from legal writers such as More, Coke, Hale, and Gilbert and from a variety of printed trials. The trial reports we have are not the best sample we might hope for because they consist disproportionately of post-1670 "state trials" of a political nature. Because I have explored the development of the standard in considerable detail elsewhere,[74] I provide only a summary here.

From the late fifteenth century on, jurors were to give their verdicts "according to your evidence and your conscience." Evidence referred to witness testimony and written documents. From Thomas More we learn that the juror must have a "sure and certain persuasion & belief in his own conscience," a conscience that has been "induced reasonably." In the late seventeenth century Hale noted "it is the conscience of the jury, that must pronounce the prisoner guilty or not guilty."[75]

"Satisfied conscience" was the most frequently voiced standard of common law courts. The process by which the conscience was to become "satisfied" was a rational, not an emotional, one, and a tradition of casu-

istry emphasized the role of reason in making rational and moral decisions under conditions of less than perfect certainty. When the conscience of jurors reached a state of a "satisfied conscience" or "moral certainty," conviction was appropriate. When they entertained reasonable doubts, they were to acquit. Neither the satisfied conscience nor the moral certainty test was considered to have the same degree of certainty as demonstration or mathematical proofs.

According to Coke, the prosecution to be successful must be uncontradicted and unanswerable.[76] From the Restoration period onward we have more abundant evidence about the standard for jury verdicts. Edward Waterhouse wrote of verdicts reached "as they think in their Conscience: the truth of the facts after hearing the evidence . . . concerning the fact." Before reaching their verdict, the jurors were to recess "to consider their Evidence, . . . they are to weigh the Credibility of Witnesses, and the Force and Efficacy of their Testimonies."[77] "A great Weight, Value and Credit" could be given such verdicts because the "unanimous Suffrage and Opinion of Twelve Men, . . . carries in itself a much greater Weight and Preponderation to discover the Truth of a Fact, than any other Trial whatsoever."[78] Another judge noted that "in all cases [tha]t depend on . . . witnesses," jurors "are to . . . weigh all Circumstances, and as they in their consciences beleev concerning [th]e testimony so are they to give their verdict."[79] The "satisfied conscience" standard was synonymous with the term "moral certainty." Late-seventeenth-century judges often used expressions such as "if you are satisfied or not satisfied with the evidence" or "if you believe on the evidence." A juror swears "to what he can infer and conclude from the testimony . . . by the force of his understanding."[80] During the early eighteenth century there was increasing reference to the understanding of the juror. Jurors "were rational men and will determine according to your consciences, whether you believe those men guilty or not."[81] Understanding and conscience were concerned with the same mental processes.

Over time judges became increasingly likely to mention doubts on the part of the jury. From the mid-eighteenth century the now familiar "beyond reasonable doubt" terminology of modern Anglo-American law was added to its cognates, "satisfied conscience" and "moral certainty." The meaning of all these phrases was identical and they often were used together.

Jurors

Given our primary concern with "fact" and "fact finding," some attention must be paid to the character of juries. Coke describes jurors as "homines liberi et legales." Earlier in their history it was hoped that

knights and substantial freeholders would serve as jurors. By the late sixteenth century and early seventeenth century, however, it was rare for the gentry to serve on trial juries. Grand jurors were on the whole of higher status than petty jurors and during the late seventeenth and eighteenth centuries were dominated by the gentry. The ideal grand jurors were "grave and substantial gentlemen" and the "most sufficient freeholders in the county."[82] Grand jurors on assize panels, however, were composed of the lesser or parish, not county, gentry.

Assize jurors, that is, trial or petty jurors, were mostly drawn from the yeoman class, and quarter sessions jurors tended to be lesser yeomen and even husbandmen. Juries were composed of modestly propertied men of the "middling classes" drawn from village elites and included artisans and tradesmen as well as yeomen. They were the leaders of village society experienced in the administration of local government but not highly educated or sophisticated men.[83] Jury service, though prestigious, was time consuming, and many sought to avoid it. Shortages meant that bystanders were not infrequently added to jury panels. Although addressed in court as "Gentlemen of the Jury," most jurors in civil and criminal cases were not actually gentlemen.[84] To ensure independence, there was a property qualification for jury service, and women, servants, and the lowest ranks of society were excluded. Those of middling economic and social status were, to use current parlance, treated as "epistemologically competent" to reach judgments about legal "facts."

Jurors were assumed to have the qualities of mind necessary to make judgments of matters of fact. They were intelligent enough to consider whether the "fact" had actually occurred and who had been responsible for it. They were considered capable of evaluating the demeanor of witnesses, comparing testimonies, spotting inconsistencies and contradictions, and evaluating the extent to which these factors affected the credibility of witnesses. Jurors were also expected to consider the moral qualities and lifestyle of those who testified.

English judges and juries were both idealized and criticized. Although the common law was lauded for its employment of juries, there was sufficient unease about juries to generate a special jurisdiction for Star Chamber over jury corruption. It was often claimed that jurors were not of sufficiently high status because inflation eroded whatever property requirements were instituted. If some, such as Interregnum law reformer William Walwyn, praised juries for "justly and faithfully, judging the cause of rich and poor without fear or favour, . . . without respect to persons," others yearned for juries of "twelve able understanding gentlemen" to replace the "weak and ignorant."[85] The Restoration Parliament and several post-1660 writers expressed similar concerns, and periodically bills were introduced to ensure "able and sufficient jurors."[86] Jurors were criticized

as "simple," "unlearned," or unsophisticated men who might be misled, and praised as capable, responsible, "of known integrity," that is, "good men and true."[87] The English governing classes praised juries, refused to serve on them, and sought means of ensuring their continued improvement. Jury composition did not change significantly, and fact determination in the common law courts continued to be the responsibility of the "middling" classes.

Social Status and Legal Facts

Legal fact finding is particularly relevant to Steven Shapin's emphasis on the importance of social status in connection with English empirical philosophy of the Restoration era. Shapin has suggested that aristocratic and courtier codes of the Renaissance, with their concerns with honor and civility, established a system of trust and trustworthiness that contributed in important ways to the construction of knowledge.[88] Although English society recognized a connection among birth, wealth, and virtue and exhibited greater inclination to trust the testimony of gentlemen than those of lower status, those assumptions alone did not determine fact finding in the courts. First of all, in England it was less clear than elsewhere who was and was not a gentleman, the gentlemanly class being a rather fluid one involving birth, wealth, and lifestyle, which to some degree were substitutable for one another.

Societal inclination to trust those of high status was undermined in a variety of ways in the legal setting. Although the justices of the peace were predominantly of the gentlemanly class, they were often criticized by assize judges for partiality.[89] Gentlemen themselves engaged in countless lawsuits that pitted the word of one gentleman against that of another. It was after all the upper classes who were most prone to litigate in the common law courts. Those with even the slightest financial interest in a civil case were excluded from testifying on the grounds of partiality and interest, gentleman or not. Gentle witnesses for both parties could not all be assumed to be telling the truth. Although one writer on the subject of "honor" indicated that "the testimony of a Gentleman ought to be received and more credited than the word of a common person,"[90] there were other considerations that sometimes modified that deference in the courtroom. Accusations of partiality and interest might be pitted against status claims. Upper-class criminal defendants no more than lower-class criminal defendants were permitted to testify on oath. In all cases testimony would be evaluated by those of the "middling classes." Even peers would be tried by ordinary juries in civil cases. On the other hand, the bias in favor of the upper classes was clearly present. Social status was one, but only one, factor in assessing witness credibility.

Although Shapin has suggested that the common people were perceived as "perceptually unreliable" during the early modern period, there is nothing in the legal literature to support such a claim. All normal men were deemed to be perceptually competent in the legal context, and there was no suggestion that either "sense" or memory, key elements in matter of fact, were less acute or accurate in those of lower status. Jurors, men of the middling classes, and legal professionals, many of whom were not quite gentlemen, were entrusted to evaluate witness testimony for reliability and credibility. Shapin also suggests that merchants in the seventeenth century were perceived to be deceitful and untruthful. Yet the law did not distinguish merchants from others. From titled aristocrat downward, all witnesses with pecuniary interests were excluded from testifying. "Interest" was not a function of social status.

No matter what their social status, some witnesses would lie and some were foolish, easily influenced, or partial or prone to self-contradictory testimony. No doubt the law incorporated general societal assumptions about trustworthiness into its own fact-finding machinery, but the law's fact finders were for the most part not gentlemen, nor were most of its testifiers as to facts. Nevertheless, in very high-stakes situations it managed to find facts accurately to its own satisfaction and to the satisfaction of sixteenth- and seventeenth-century Englishmen generally. Throughout this period social status was one factor among many to be taken into account in the assessment of the credibility of witnesses by a body of some gentle, but mostly nongentle, persons deemed fully capable at arriving at the truth of the facts.[91]

The Norm of Impartiality

Recent studies of early modern English natural philosophy have noted the emphasis on impartiality among the advocates of the new empiricism and attribute it either to humanist efforts to polish academic manners or to gentlemanly mores.[92] The legal system and its concern with establishing matters of fact may have been a greater influence. Efforts to ensure impartiality have always been at the heart of the legal enterprise. Both the Romano-canon and the common law systems attempted to ensure it by a variety of institutional forms. The common law attempted to reduce or eliminate partiality and bias in jurors, judges, and witnesses while assuming partiality in the litigating parties and their lawyers.

Jury Impartiality

The common law provided for juror challenges to prevent favoritism, corruption, and bias. Jurors "are not to be of the Kindred or Alliance of any of the Parties. And . . . Not to be such as are prepossessed or

prejudiced before they hear their Evidence." Parties were to have "notice of the Jurors, and of their Sufficiency and Indifferency, that so they may make their Challenges . . . if there be just Cause." Those of insufficient freehold too were unfit to try causes. Only twelve "indifferent" judges of the fact were to be sworn. Star Chamber punished corrupt jurors for egregious violations and "false" verdicts, and jurors might be fined until 1670. Jurors as judges of the fact were often reminded of their duty to be impartial, and even defendants reminded jurors to "put on indifferent eyes."[93]

Judicial Impartiality

It would be difficult to find a Western legal system that did not emphasize the importance of judicial impartiality. The English judiciary quite naturally adopted the norm, which applied to judges, to jurors who were judges of fact, and to justices of the peace acting in their capacity as judges. Queen Elizabeth had enjoined judges "to administer the law and justice indifferently without respect of persons."[94] Similar statements about impartiality and the "indifference of the court" were made by William Lambarde and Sir Edward Coke.[95] "All those that have the Administration of Justice committed to them" were "to behave with all Equity and Impartiality."[96]

Such rules as not allowing judges to go on assize in their own counties were designed to increase impartiality. Hale insisted on the importance of judicial rulings on exceptions to competency and other evidentiary matters being made publicly so that any "Partiality, and Injustice will be evident to all By-standers."[97] The impartiality norm required that judges must not give their opinion before all the evidence had been heard.[98] Hale enjoined "an entire absence of affection and passion which will easily occasion a wresting of judgment." Judging required a "temperate mind totally abandoning all manner of passion, affection, and perturbation so that he may come to the business with clearness of understanding and judgment."[99] Isaac Barrow summarized the conventional wisdom: "For as he is a good judge, who after a full cognisance, and carefull discussion of the case . . . doth pronounce freely and fairly, being no way swayed either by his own inclination, or by temptation from without, who is not byassed by any previous affection or dislike, not drawn by favour, not daunted by fear, not bribed by profit, not charmed by flattery, not dazzled by specious appearance, not gulled by crafty insinuations, or by fine speech; not tired by solicitation or importunity, not seduced by precedents or custome."[100]

The norm of impartiality did not imply modern judicial behavior. Early in the seventeenth century imperious judges often gave "Light and Assistance" to the jurors by "weighing the evidence before them . . . and by shewing them his Opinion even in Matter of Fact, which is a great Advan-

tage and Light to Lay-Men . . . in investigating and enlightning the Matter of Fact, whereof the Jury are Judges."[101] Judges were not reluctant to interfere with juries, and several legal historians have argued that juries took their lead from the bench throughout the period.[102] Judicial influence was perhaps most obvious when judges summed up the evidence, but we do not how common this practice was. A major jury defense against excessive judicial influence was the notion that jurors might have direct knowledge of fact and witness credibility quite apart from the testimony presented in court.[103] Essentially for political reasons, this idea persisted long after juries had become unlikely to have such direct knowledge. As Hale noted, "If the judge's opinion must rule the matter of fact, the trial by jury would be useless."[104] Standards of judicial behavior were modified over the course of the seventeenth century. The ideal of impartiality was a constant, but the hectoring and overbearing behavior of Sir Edward Coke would not have passed muster as an appropriate model of judicial behavior in the age of Judge Holt.

The norm of judicial impartiality, however, was not always practiced and certainly not always seen to be practiced. Judges could "never escape the imputation of partiality and injustice from some party."[105] Particular judges were felt to be less than disinterested, especially in cases where royal interests appeared to be pitted against the property rights of subjects, where political interests were at stake, or where judges were thought have been bribed or unduly influenced by one of the parties. But demands for judicial impartiality were not simply platitudes. The 1620s witnessed the impeachment of Francis Bacon, Lord Chancellor of England, for judicial corruption and other judicial misbehavior. At the outbreak of the civil war several of Charles I's judges lost their offices. Such removals, more often than not motivated by political considerations, were made in the guise of efforts to regain judicial disinterestedness and impartiality. The issue of judicial partisanship was again raised during the reigns of Charles II and James II as Whigs attacked "Tory" judges. Only in 1696 did judges become irremovable from office by the Crown except for violations of the standard of "good behavior."[106]

Thus in early modern England impartiality was neither an unexamined assumption nor a subject of value conflict but rather an ever present and hotly defended norm of judicial conduct. And this norm had been and continued to be central to legal discourse quite independently of humanist concerns and gentlemanly codes.

Impartial Witnesses

We have noted the ways in which the courts attempted to ensure that witnesses would be impartial. Clearly, the ideal witness was the impar-

tial witness, and "that which is reported by persons disinterested" was preferable to "that which is reported by persons of whose interest it is to have the thing true, or believed to be true."[107] Witness were most credible when "wholly indifferent and unconcerned." Indeed, their credit was "to be taken from their perfect indifference to the point in question." When "a man who is interested in the Matter in Question would also prove it, 'tis rather a Ground for Distrust rather than belief; for men are generally so short-sighted as to look at their own private Benefit, which is near to them, rather than the Good of the World, that is more remote."[108]

The quest for the much-praised impartial and disinterested witness, however, resulted in unanticipated problems. For instance, exclusion of financially interested parties from testifying in civil suits meant that those best informed about the issue in question were not permitted to testify—even if their pecuniary interest was minute. Only in the late eighteenth century did judges begin to allow the testimony of financially interested parties and to let jurors decide whether or not it should be believed.[109]

Impartiality—Lawyers—Rhetoric

The English mixed respect for and hostility toward the legal profession. Lawyers were supposed to be partial because they represented the contesting parties in adversarial proceedings. Apprehension was expressed that the "learning, art, and eloquence" of the lawyers might "seduce the minds" of unsophisticated jurors.[110] Lambarde, Hale, and Isaac Barrow suggested that the rhetorical skills of the lawyers might undermine the impartiality of courts. Courtroom eloquence, Hale indicated, "bribes [the jury's] fancies and bias[es] their affections"; Barrow noted the dangers of "crafty insinuations" and "fine speech" that detracted from impartiality.[111] John Hawles, a Whig polemicist of the 1680s, suggested that the "best judicatures of the world . . . utterly reject the use of Rhetoric," implying that the "Art of Persuading" was little different than deceit. Sir George Berkeley was confident that on the Day of Judgment neither the "voluble Oratory" nor "subtile Law-distinctions" typical of the lawyer would in "any way avail."[112]

All the discourses of "fact" became suspicious of rhetoric and often voiced this suspicion in connection with announcing their dedication to the norm of impartiality. The disciplines of law and historiography, however, were somewhat ambivalent about rhetoric, decrying its dangers on the one hand and incorporating it on the other. The adversarial character of the common law was premised on the belief that contending, partial, and interested parties, with the help of contending lawyer advocates, could reach the truth of particular facts, or rather that judge and jury could reach it for them. Counsel were expected to use the available means

to win their case, but what means were available was determined by legal rules.

The English legal system, like that of the Continent, was sensitive to the norm of impartiality. The norm was frequently stated with respect to both jurors and judges and in the rules relating to admissible witness testimony. If the norms with respect to prejudice, bias, and partiality were not always observed, they were constantly reiterated, and a variety of procedures existed to assist in achieving them. The English legal system attempted to create institutional settings and procedural mechanisms that would facilitate truthful judgments about past human events and actions. The legitimacy of the legal enterprise was built on the foundation of impartiality.

An Epistemological Conclusion

Now that we have examined the meaning of "fact" and the elements of fact determination in a legal setting and reviewed the various participants in that process, we turn to the epistemological aspects of legal fact finding. In doing so we consider the courtroom,[113] as others have considered the scientific experiment, as a site of knowledge making, that is, a setting where a variety of participants engage in creating or determining the "truth" of something by a set of site-specific rules. In the courts juries, judges, witnesses, and counsel participated in a process that was designed to produce "morally certain" verdicts in "matters of fact." By following certain procedures, using written documents of specified types, listening to witness testimony produced by certain kinds of persons and under certain conditions, and considering "circumstances," "judges of the fact" were able to produce just and true knowledge of "matters of fact." This practice was shaped in a number of ways by the norm of impartiality.

Courts were sites of epistemological inquiry, but they were also part of a larger political, administrative, and legal system and thus were sometimes sites of ideological conflict. Courts had a moral as well as an empirical function so that juries sometimes reached judgments clearly against the evidence in order to achieve what they felt to be a just result. The jury's primary function, however, was to make what society believed to be epistemologically sound findings about events or "facts" under conditions that were recognized to be imperfect. The security of life and property, deeply held cultural values, depended on these outcomes.

The common law made several epistemological assumptions that were not spelled out in great detail or in philosophical form and intermingled old and new learning. These were perhaps best summarized by Sir Geoffrey Gilbert, who emphasized that although firsthand sense data was the best source of knowledge, it was of limited usefulness to courts because the law dealt with "transient things" of no "constant being" that had to be retrieved by memory. When we "cannot see or hear any thing ourselves, and

yet are obliged to make a judgment of it," it is necessary to "see and hear by report from others." It is reasonable to give "faith and credibility . . . to the honesty and integrity of credible and uninterested witnesses, attesting any fact under the solemnities and obligations of religion, and the dangers and penalties of perjury." When such conditions are met, the mind "equally acquiesces as on a knowledge by demonstration, for it cannot have any more reason to be doubted than if we ourselves had heard and seen it."[114]

Although Gilbert's formulation is more sophisticated than those of his predecessors, their assumptions and conclusions were roughly the same. They assumed that it was possible to arrive at sound judgments about facts, that is, events and deeds, though those events involved actions that could not be observed or replicated by those doing the fact finding. Sound judgments could be arrived at by examining the testimony of those who had seen or heard the events. In order to make such judgments it was necessary to examine the quality and quantity of testimony, to be suspicious of hearsay, and to consider any relevant "circumstances." Oaths were assumed to enhance the probability of testimonial truth but not to ensure it. It was also assumed that institutional arrangements and procedures, such as the right to challenge jurors or to exclude witnesses with financial interests, would help ensure just and truthful fact determination. Whatever their origins and evolution, such rules were perceived as ensuring accurate judgments of fact.

Some matters of fact might be considered "proved" and others doubtful or false. "Fact" in this context did not necessarily refer to an established truth but often to an issue of truth. Indeed, one of the great changes that occurred over the course of two centuries in some cultural arenas was the transformation of "fact" from something that had to be sufficiently proved by appropriate evidence to be considered worthy of belief to something for which appropriate verification had already taken place.

Litigation is not compatible with a skepticism so extreme that nothing can be known and no decision be worthy of acceptance. English law of the early modern era existed in an epistemological space of probability, reasonable doubt, and moral certainty in which decision making could not be delayed indefinitely on the grounds of insufficiently certain knowledge.

The fact-determination process of the common law was not quite one of "free proof." It was, however, far freer than that of the Romano-canon system with its rigid rules about numbers of witnesses. Juries were barred from exposure to some evidence by rules that excluded certain categories of persons from presenting evidence. Early modern juries were not yet prevented from hearing hearsay, though the tendency was in that direction. Until the early eighteenth century some testimony was given under oath and some was not.

During the sixteenth and seventeenth centuries there flourished a legal

culture of fact built on the concept "matter of fact." The legal system was pervaded by the belief that ephemeral "facts" of human action could be established with a high degree of certitude and that ordinary persons had sufficient ability to evaluate testimony for credibility and documents for authenticity in order to arrive at impartial, truthful verdicts guided by their intelligence, reason, and conscience. Confidence in the jury system thus contributed to the general feeling that ordinary persons, if financially independent and if situated in institutional settings with the appropriate safeguards, were capable of determining matters of fact. Whatever the defects of the jury trial, the English preferred the common law fact-determination process to other varieties in other venues. That setting required empaneling impartial, disinterested fact evaluators and impartial, disinterested judges who operated in public rather than closed settings. Although actual judges and juries did not always meet these standards, the jury system was praised as the best means of finding the truth.

The legal concept "fact" and the epistemological assumptions and procedures associated with jury fact determination became well known to large numbers of Englishmen, not only to legal professionals but also to those who served on juries, potential jurors, frequenters of trials, justices of the peace, and grand jurors. The spate of published criminal trials, especially state trials, dating from the 1670s onward also made the evidentiary elements of the common law criminal trial familiar to a large number of general readers and the politically interested. A large proportion of the upper and "middling" classes, both urban and rural, had encountered the concept of fact and the common law approach to establishing "matters of fact." In this period references to legal fact finding were liberally scattered through the literatures of other disciplines.

Studying the process of knowledge making in the legal arena is obviously difficult, not only because of the lack of material but because the process involved institutions that were embedded in a larger political arena and were evolving over time. Despite the difficulties, it is important for cultural historians in general, and historians of science and philosophy in particular, to become more aware of a legal culture that established a widely admired mode of establishing correct beliefs in the world of "fact." During the early modern era the English legal system had produced a well-accepted epistemological framework and a method of implementing it that worked reasonably well in reaching judgments of "fact" necessary to making important social decisions. Much of this epistemology and method could be and was transferred to other sites of knowledge and other knowledge-making situations.

The remainder of this book is concerned with showing how legal concepts and practices related to fact finding were first extended into other disciplines that dealt with human actions and then to the "facts" of natural

and divine phenomena. By the end of the seventeenth century the epistemological thinking characteristic of legal fact finding came to pervade English thought and culture. Legal modes of establishing appropriate belief played a larger role in the development of truth-establishing practices than has hitherto been recognized.

Not all aspects of the legal tradition would become relevant to other areas of learning. None of the other fields we survey made use of oaths or used adversarial institutional forms that required witnesses, juries, lawyers, and judges. And none was under the kind of pressure to reach immediate decisions on the facts that juries were. But to the extent that their concerns were with verifying events or actions, human, natural, or divine, they came to use many of the concepts embedded in the English legal system that we have been examining.

Notes

Introduction

1. See Barbara Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983). See also Donald Kelley, "The Problem of Knowledge and the Concept of Discipline," in *History and the Disciplines: The Reclassification of Knowledge in Early Modern Europe*, ed. Donald Kelley (Rochester, N.Y., 1997), pp. 13–28.
2. Sociologist Niklas Luhmann treats law as an autonomous intellectual and professional tradition that is nevertheless responsive to and capable of absorbing extralegal developments. *Autopoietic Law: A New Approach to Law and Society*, ed. Gunther Teubner (Berlin, 1988).

Chapter 1: "Fact" and the Law

1. R. C. Van Caenegem, "The History of European Civil Procedure," *Encyclopedia of Comparative Law* (Tubingen, 1972), 16:13. But see Robert Barett, *Trial by Fire and Water: The Medieval Judicial Ordeal* (Oxford, 1986), pp. 34–41. Barett suggests that the ordeal was not abandoned because it became irrational but became irrational because it had been abandoned (p. 86).
2. See Barbara Shapiro, *"Beyond Reasonable Doubt" and "Probable Cause": Historical Studies of the Anglo-American Law of Evidence* (Berkeley, 1991).
3. *Da Mihi facto dabo tibi ius.* The distinction appears in most canon and civil law procedurals but was not part of the law of the early Romans. See *Le fait et le droit: Etudes de logique juridique* (Centre Nationale de Recherches de Logique, Brussels, 1961), p. 25. The distinction appears in Quintilian, *Institutes of the Orator*, Loeb ed. (Cambridge, Mass., 1969), III, v, 4, 7.
4. In Latin "matter of fact" was sometimes rendered "res facta." The French used "fait" and "droit," the Spanish "questions de hecho" and "questions de derecho."
5. More is known about the practice of eighteenth-century courts.
6. Pleading by legal professionals in the central courts brought a case to an issue. When the issue had been reached, local juries determined the facts relating to that issue.

7. *Trial of Lawrence Bradden* (London, 1684), p. 61.
8. Sir Edward Coke, *The Third Part of the Institutes of the Laws of England* (London, 1819), p. 29; *A True Narrative of the Proceedings at the Hertford Assizes* (London, 1676), p. 76; *The Trial of John Giles* (London, 1681), p. 3; *The Trial of Lord Mohun* (London, 1699), p. 55.
9. William Lambarde, *Eirenarcha* (London, 1614), pp. 218, 219. See also Cicero, *De inventione*, I.34–43, 48; *Rhetorica ad herennium*, Loeb Classical Library, vol. 2 (Cambridge, Mass., 1954), I.8.
10. See Van Caenegem, "History of European Civil Procedure," p. 29; Morris S. Arnold, "Law and Fact in the Medieval Jury Trial: Out of Sight, Out of Mind," *American Journal of Legal History* 18 (1974), 268–280; F. F. C. Milson, "Law and Fact in Legal Development," *University of Toronto Law Review* 17 (1969), 1–19; James Bradley Thayer, *Preliminary Treatise on Evidence at the Common Law* (1898; reprint New York, 1969), pp. 183–261; Jerome Lee, "The Law-Fact Distinction: From Trial by Ordeal to Trial by Jury," *AIPLA Quarterly Journal* 12 (1984), 288–294.
11. Thayer, *Preliminary Treatise on Evidence*, pp. 182–185. See also pp. 185–200. Thayer believed that Coke's formula came into existence in the sixteenth century. "Law and Fact in Jury Trials," *Harvard Law Review* (1890), 147–175. See also Alessandro Giuliani, "The Influence of Rhetoric on the Law of Evidence and Pleading," *Juridical Review* 62 (1969), 217.

"Choses en fait" does not appear in dictionaries of law French or the earliest English law dictionaries. See F. O., *Law French Dictionary*, 2d ed. (London, 1718). "Fait" appears as "deed," and meant deed in both senses of sealed documents and action. "Fait de dieu" was an act of God. J. H. Baker, *Manual of Law French*, 2d ed. (Aldershot, 1990). The term does not appear in John Rastell, *Expositions of the Terms of the Lawes of England* (1567) or in John Cowell, *The Interpreter or Book Containing the Significations of Words* (1607). Cowell and most subsequent writers distinguished "matter in deed" from "matter of record." "Matter in deed seemeth to be nothing else but a truth to be proved, . . . though not by any record." Giles Duncombe used "Choses en fait." *Tryals per Pais or the Law of England Concerning Juries by Nisi Prius* (London, 1682), p. 4.
12. See John Guy, ed., *The Debellacyon of Salem and Bizance*, in the *Complete Works of St. Thomas More* (New Haven, 1987), X, 1–232.
13. Francis Bacon, *Baconiana . . . Remains of Sir Francis Bacon*, 2d ed. (London, 1684), pp. 22–23, 30, 36.
14. Thomas Blount, *Law Dictionary* (London, 1670); Duncombe, *Tryals per Pais*, pp. 1–2. See also Edward Leigh, *A Philological Commentary* (London, 1658), p. 135; Anchitell Grey, *Debates of the House of Commons from the Year 1667 to the Year 1694*, 10 vols. (London, 1769), I, 448.
15. See Thomas A. Green, *Verdict According to Conscience: Perspectives on the English Criminal Trial Jury, 1200–1800* (Chicago, 1985), pp. 153–199. In special verdicts the judges dealt with both law and fact. Jurors sometimes engaged in "nullification," giving the verdict they wished regardless of the evidence. See ibid., pp. 255–257, 259.
16. See *Twelve Good Men and True: The Criminal Trial Jury in England, 1200–1800*, ed. J. S. Cockburn and Thomas A. Green (Princeton, 1988). Sir John Fortescue's fifteenth-century *De Laudibus Legum Angliae* already distinguishes witnesses from jurors (ed. S. B. Chrimes [Cambridge, 1942], chap. 26); J. H. Baker, *The Reports of Sir John Spelman*, 2 vols. (London, 1977–78), II, 106, citing *Deballacyon of Salem and Bizance* (1533).
17. See John Langbein, *Prosecuting Crime in the Renaissance* (Cambridge, Mass., 1974). For cross-examination, see Sir Thomas Smith, *De Republica Anglorum*, ed. Mary Dewar, 2 vols. (Cambridge, 1982), II, 15; Sir Geoffrey Gilbert, *The Law of Evidence* (London, 1805), pp. 61, 62, 132.
18. Coke, *Third Part of the Institutes* (1644), p. 163; Francis Bacon, *The Works of Francis Bacon*, ed. James Spedding, Robert Leslie Ellis, and Douglas Denon Heath, 15 vols. (London, 1857–72), I, 513.
19. Juries could reach verdicts in the absence of evidence presented in court.
20. See Matthew Hale, *Historia placitorum coronae or History of the Pleas of the Crown*, 2 vols.

(London, 1736), II, 241; Gilbert, *Law of Evidence*, p. 65. There were, however, concerns about forgery.

21. Gilbert, *Law of Evidence*, pp. 3, 148.

22. Ibid., pp. 139–140, 144.

23. Exclusion of interested testimony meant that not all the available evidence could be heard.

24. *The Tryal of . . . London Apprentices* (London, 1668), p. 44. See also *The Trial and Condemnation of . . . Charnock* (London, 1696), pp. 67–68; *The Tryal of Sir Tho. Gasgoyne for High Treason* (London, 1680), p. 444; Gilbert, *Law of Evidence*, p. 149.

25. M. Macnair, "'A Fragment on Proof,' by Francis North, Lord Guildford," *Seventeenth Century* 8 (1993), 143. Pardoned felons could serve as witnesses but not as jurors. Hale, *History of the Pleas of the Crown*, pp. 277–280.

26. Bacon, *Works*, I, 513; Hale, *History of the Pleas of the Crown*, 1736, I, 635; Sir Matthew Hale, *History of the Common Law of England*, ed. Charles M. Gray (Chicago, 1971), p. 164.

27. More, *Debellacyon*, p. 157; Gilbert, *Law of Evidence*, p. 147.

28. Hale, *History of the Common Law*, pp. 154, 165.

29. See Langbein, *Prosecuting Crime*; Shapiro, *Beyond Reasonable Doubt*, pp. 148–164.

30. Dalton, *The Country Justice* (London, 1635), p. 297. Several items on Dalton's list appear in Cicero and Quintilian. See Shapiro, *Beyond Reasonable Doubt*, p. 117.

Tancred's thirteenth-century treatise already noted that faced with conflicting testimony judges were to "follow those who are most trustworthy—the freeborn rather than the freedman, the older rather than the younger, the many of honorable estate rather than the inferior, the noble rather than the ignoble, the man rather than the woman. Further, the truth-teller is to be believed rather than the liar, the man of pure life rather than the man who lives in vice, the rich man rather than the poor, anyone rather than he who is a great friend of the person for whom he testifies or an enemy of him against whom he testifies. If the witnesses are all of the same dignity and status, then the judge should stand with the side that has the greatest number of witnesses. If they are of the same number and dignity, then absolve the defendant." Charles Donahue, Jr., "Proof by Witnesses in the Church Courts of Medieval England: An Imperfect Reception of the Learned Law," in *On the Laws and Customs of England*, ed. Morriss Arnold (Chapel Hill, N.C., 1981), p. 131.

31. Cicero suggests inference might be drawn from the person of the accused from such personal attributes as age, ancestors, temperament, physical condition, way of life, fortune, and interest. *De inventione*, II, x, 34–36. See also II, xiii, 43.

32. See Shapiro, *Beyond Reasonable Doubt*, pp. 114–243.

33. Gilbert, *Law of Evidence*, p. 149.

34. John Langbein, "Historical Foundations of the Law of Evidence: A View from the Ryder Sources," *Columbia Law Review* 96 (1996), 1186–1190. But see John H. Wigmore, "History of the Hearsay Rule," *Harvard Law Review* 17 (1904), 436–458; R. W. Baker, *The Hearsay Rule* (London, 1950); Edward M. Morgan, *Some Problems of Proof under the Anglo-American System of Litigation* (New York, 1956).

35. Hale, *Primitive Origination*, p. 128; *Trial of Charnock*, p. 67; John Locke, *An Essay Concerning Human Understanding*, ed. A. Frasier, 3 vols. (New York, 1959), chap. 14, sec. 10.

36. Wigmore, "Hearsay Rule," pp. 443–447; Gilbert, *Law of Evidence*, p. 153, citing Francis Buller, *Introduction to . . . Trials at nisi prius*, pp. 294–295. See also James Oldham, "Truth-Telling in the Eighteenth-Century English Courtroom," *Law and History Review* 12 (1994), 104.

37. Courts, however, heard those under twelve without oath "which possibly being fortified with concurrent evidence may be of some weight, as in case of rape, buggery, witchcraft, and such crimes, which are practiced upon children." Hale, *History of the Pleas of the Crown*, 1736, II, 235–237; Gilbert, *Law of Evidence*, p. 143.

38. Macnair, "Fragment on Proof," p. 143. "Light and inconsiderable witnesses" were less credible. Hale, *Primitive Origination*, p. 128. Justicing manuals refer to upbringing, education,

whether suspects and witnesses were of idle or honest occupation, riotousness in diet or apparel, whether brawling, quarrelsome, or light-fingered, and whether they were gamesters or haunters of alehouses. Lambarde, *Eirenarcha* (1614), p. 218; Richard Crompton, *L'office et auctoritie de justice de peace* (London, 1606), p. 100r.

39. Quoted in Hubertus Schulte Herbruggen, "The Process against Sir Thomas More," *Law Quarterly Review* 99 (1983), 113–136. See also Shapiro, *Beyond Reasonable Doubt*, pp. 212–213. The defendant in the Trial of Throckmorton discussed the credibility of witnesses. T. B. Howell, *Complete Collection of State Trials*, 34 vols. (London, 1809–1826), I, 878–881. See also I, 1019, 1071.

40. Cynthia Herrup, *The Common Peace: Participation and the Criminal Law in Seventeenth-Century England* (Cambridge, 1987); *Historical Collections* (London, 1681), pp. 97, 102, 103, 106, 108. Hobbes, *Leviathan* (London, 1975), p. 57.

41. Hale, *History of the Pleas of the Crown*, 1736, II, 279.

42. Gilbert, *Law of Evidence*, p. 155.

43. For efforts to remove Roman Catholic justices of the peace, see J. S. Cockburn, *A History of the English Assizes, 1558–1714* (Cambridge, 1972), pp. 191, 200–219.

44. *The Trial of Sir Thomas Gascoyne* (London, 1680), pp. 64, 67. In a 1696 treason trial the defendant objected to the testimony of Roman Catholics witnesses because they might be absolved by pope or priest if they swore falsely. King's Counsel countered that "it was never allowed, or indeed objected, that I know of, before, that Roman Catholics were not good Witnesses. A Roman Catholick may be an honest man, not withstanding his religion." If they were competent to testify, their credibility was for the jury to weigh. *The Arraignment . . . of Sir John Friend* (London, 1696), pp. 36, 38. According to Gilbert, papist recusants could not be witnesses; neither could infidels, because they were not under the obligations of "our religion." The "binding force" of oaths ceased when the "reason and grounds of belief" were "absolutely dissolved." Jews might testify on the Old Testament because "their oaths do induce a belief of the fact, which they attest." Gilbert, *Law of Evidence*, p. 143.

45. Hale, *History of the Pleas of the Crown*, II, 276, 277; Hale, *History of the Common Law*, p. 163.

46. William Best's later work summarized the position of the seventeenth century. Best, *The Principles of the Law of Evidence*, 6th ed. (London, 1875), pp. 18–22. See also p. 24.

47. Gilbert, *Law of Evidence*, p. 155.

48. Physicians might be asked whether the "fact" was attributable to natural causes. See Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983), pp. 204, 208; Robert Kargon, "Expert Testimony in Historical Perspective," *Law and Human Behavior* 10 (1986), 15–20; Catherine Crawford, "Legalizing Medicine: Early Modern Legal Systems and the Growth of Medico-Legal knowledge," in *Legal Medicine in History*, ed. Michael Clark and Catherine Crawford (Cambridge, 1994), pp. 89–116; Stephan Landsman, "One Hundred Years of Rectitude: Medical Witnesses at the Old Bailey, 1717–1817," *Law and History Review* 16 (1988), 445–495.

49. Hale, *History of the Common Law*, p. 164; Hale, *Primitive Origination*, p. 128; Locke, *Essay Concerning Human Understanding*, bk. 4, chap. 4, sec. 6. Keith Thomas, *Religion and the Decline of Magic* (New York, 1979), p. 473.

50. George Fisher, "The Jury's Rise as Lie Detector," *Yale Law Journal* 107 (1997), 575–714. Fisher emphasizes the necessity of believing either prosecution or defense witnesses, ignoring the possibility that the testimony of prosecution witnesses might vary and that only some might be believed. The jury is viewed as "lie detector" rather than as determiner of "reasonable belief." Isaac Watts, however, insisted on consideration of whether those who oppose testimony are "equally skillful and equally faithful as those who assert it." *Logick, or the Right Use of Reason in the Inquiry after Truth* [1724] (London, 1775), pp. 181–182. See also pp. 266–271.

51. Hale, *History of the Common Law*, p. 164.

52. Hale, *Primitive Origination*, p. 130; Gilbert, *Law of Evidence*, pp. 104, 147–148, 151. If wit-

nesses agreed in minute circumstances, it might be "a story laid and concerted beforehand." Ibid., p. 151.

53. State trials suggest that the need for two witnesses is sometimes agreed on by both prosecution and defense and at other times only the defendant insists on it. See *The Tryal of Henry Baron Delamere* (London, 1686); *The Trial and Conviction of John Hamden* (London, 1684). See also Samuel Reznick, "The Trial of Treason in Tudor England," in *Essays in History and Political Theory in Honor of Charles Howard McIlwain*, ed. Carl Wittke (Cambridge, Mass., 1936), pp. 258–288; L. M. Hill, "The Two-Witness Rule in English Treason Trials: Some Comments on the Emergence of Procedural Law," *American Journal of Legal History* 12 (1968), 95–111. *The Draught of a Bill, now in Parliament* (n.p., n.d.) discussed recent practice.

54. Macnair, "Fragment on Proof," p. 143.

55. Gilbert, *Law of Evidence*, p. 147.

56. Ibid.; More, *Works*, X, 157.

57. Crompton, *L'office*, p. 110v. The rule is also found in canon and civil law. *A True Relation of the Unjust Accusation of Certain French Gentlemen* (London, 1671), p. 19; Hale, *History of the Common Law*, p. 164; Gilbert, *Law of Evidence*, p. 147.

58. Hale, *History of the Common Law*, pp. 163, 164.

59. *The Book of Oaths* (London, 1649), p. 207. Oaths administered for civil and criminal trials contain the same language. The latter included a statement about the avoidance of malice, hatred, evil will, greed, favor, or affection. Ibid., pp. 205–207. See also *The Book of Oaths* (London, 1689), pp. 112–115. During the Anglo-Saxon era they swore, "In the name of Almighty God, . . . in true witness stand, unbidden and unbought, so I with my eyes over-saw and with my ears over-heard" that which I say. Benjamin Thorpe, ed., *Ancient Laws and Institutes of England*, 2 vols. (London, 1890), I, 181. See Helen Silving, "The Oath, I," *Yale Law Journal* 68 (1959), 1329–1390.

60. More, *Debellacyon*, p. 160.

61. Coke suggests perjury laws, which dated from the Conquest, were not enforced because the penalties were so harsh. *Third Part of the Institutes*, pp. 163, 165. See Michael Gordon, "The Invention of a Common Law Crime: Perjury and the Elizabethan Courts," *American Journal of Legal History* 24 (1980), 145–170.

62. Publications relating to oaths focused on their lawfulness, questioned by Quakers; oaths of loyalty and allegiance; and the common practice of "loose swearing." Discussion was indebted to scholastic treatments of assertory and promissory oaths. John Gauden's *Discourse Concerning Public Oaths* (London, 1662) indicated that the oath of the "common swearer" could not be given much credit (p. 17). For Hobbes, oaths were purposeless "without fear" on the part of those swearing. *The Elements of the Law*, ed. Ferdinand Tonnies (Cambridge, 1928), chap. 16, sec. 16. For perjury, witnesses, and oaths, see More, *Debellacyon*, pp. 155–162. For the importance of oaths in trials, see *A Guide to English Juries* (London, 1682), pp. 49–50; *Perjury the National Sin* (London, 1690), p. 4; John Cheney, *A Vindication of Oaths and Swearing* (London, 1677), pp. 6, 10, 14. Although oaths had "lost their ancient force," they were "the highest and strongest assurance that can be given of the truth in Cases of Testimony, depending upon the credit and veracity of him that swears." Cheney, *Vindication of Oaths*, pp. 23, 36. Thomas Comber's *Nature and usefulness of Solemn Judicial Swearing* (London, 1682) also noted the "slight and irreverent giving of Oaths (too common in our Courts of Justice)" (pp. 22, 25). John Allen, *Of Perjury* (London, 1682), similarly observed, "The times are notoriously pester'd disturb'd and endanger'd by the variety and frequency of Perjury" but nevertheless thought oaths remained "the best means to find out the truth of Matter of Fact, to determine of Right and Wrong . . . to clear the Innocent, and discover the Guilty" (pp. 1, 3, 15). John Tombes too assumed that perjury in judicial proceedings was common. One "should not swear a thing to be so or not unless he know it to be so or not; He must not relie on Conjectures, Rumours, or probabilities." *Sephersheba: or the Oath Book* (London, 1662), pp. 72 ff., 114, 133. Many believed perjuries to be "very little sins, or rather none at all." *Perjury the National Sin* (London, 1690), p. 4. See also pp. 10, 14–15. Isaac Barrow noted

the frequency of "rash and vain swearing" and its ill effect on legal proceedings. Barrow, *Works*, 3 vols. (London, 1700), I, 194, 195, 198. John Tillotson emphasized both the "growing evil and mischief" of breaking oaths and the oaths as "the surest ground of Judicial proceedings." Though oaths did not ensure "a certain and infallible decision of things according to truth and right," they provided "the utmost credit that we can give to any things, and the last resort of truth and confidence among men; . . . if the Religion of an Oath will not oblige men to speak truth, nothing will." An assertory oath is defined as one in which someone "affirms or denies upon oath a matter of fact, past or present; when he swears that a thing was, or is so, or not so." "And where mens estates or lives, are concerned, no evidence but what is assured by an Oath will be thought sufficient to decide the matters." *The Lawfulness and Obligation of Oaths; A Sermon Preached at the Assizes* (London, 1681), preface, pp. 3, 4, 6, 7, 10, 24, 26, 28, 29.

William Wake, noting that the frequency of swearing had "taken off from their Reverence . . . and disposed . . . [persons] to Swear more carelessly, and with lesser consideration than they ought to do," desired the perjury statutes to be solemnly declared at every assize and recommended "strict exaction of penalties." *A Practical Discourse Concerning Swearing* (London, 1696), preface, pp. 7, 15, 16, 34, 125, 138–139. Oaths, which were often "not to be trusted," left even the wisest men "not know[ing] which way to turn themselves in giving judgment." One must therefore "use all diligence, not only by examining witnesses, but observing circumstances, comparing testimonies, casting in Quaeries . . . to search out the matter." Thomas Bradley, *A Sermon Preached . . . at the Assizes* (York, 1663), pp. 34, 35. Both respect for and disregard of oaths in legal proceedings were obviously common. But see Fisher, "Jury's Rise as Lie Detector."

63. Because the presumption did not hold for those convicted of falsehood or crimes against the common principles of "honesty and humanity," their testimony was "of no weight." The same was true of notorious and public criminals. Such persons were excluded from testifying. Gilbert, *Law of Evidence*, pp. 140–141.

64. See Fisher, "Jury's Rise as Law Detector."

65. Hale, *History of the Pleas of the Crown*, 1736, II, 279; I, 635; Macnair, "Fragment on Proof," p. 143; Gilbert, *Law of Evidence*, p. 139, citing Coke Lit 6, b. 1561 and 1581. See also p. 140.

66. Macnair views the trials of this era as a turning point in the law of evidence. "Fragment on Proof," pp. 143–148.

67. Hale, *History of the Pleas of the Crown*, 1736, I, 635.

68. *The Petty Papers*, ed. Marquis of Lansdowne, 2 vols. (London, 1927), II, 204–206.

69. *Book of Oaths*, p. 203.

70. Coke, *The First Part of the Institutes of the Laws of England* (London, 1817), sec. 1.6b. See also Shapiro, *Beyond Reasonable Doubt*, pp. 209–243.

71. *Trial of Charnock*, p. 68; *Arraignment . . . of Sir John Friend*, p. 43. *Arraignment . . . of Sir William Parkins* (London, 1696). p. 38. In another case the Solicitor General argued "that there may be Circumstances so strong and cogent, so violent" as to "fortify a positive Testimony, that will in Law amount to make a second Witness such as the Law requires." *The Tryal of Henry Baron Delamere* (London, 1686), pp. 78–79. The Lord Steward insisted "substantial Circumstances joyned to one Positive Testimony" was enough, according to the opinion of all the judges of England (p. 85). But one must distinguish between "bare Circumstances and bare Suspicions" that were "no Proof against any Man" and the "violent and necessary" circumstances that might substitute for a second witness (p. 82). See also *The Trial of John Hamden* (London, 1684), p. 39.

72. Violent presumption existed "when circumstances are proved that do necessarily attend the fact." Gilbert, *Law of Evidence*, pp. 147, 157, 158.

73. *Trial of Peter Cook* (London, 1696), p. 55.

74. Shapiro, *Beyond Reasonable Doubt*, pp. 1–41; Barbara Shapiro, "'To a Moral Certainty': Theories of Knowledge and Anglo-American Juries, 1600–1750," *Hastings Law Journal* 38 (1986), 153–193. We know very little about how the standard for civil cases evolved.

75. Baker, *Reports of Spelman*, II, 112, citing a 1465 case; More, *Debellacyon*, p. 160; Hale, *History of the Pleas of the Crown*, 1736, II, 314.
76. J. H. Baker, "Criminal Courts and Procedure at Common Law," in *Crime in England, 1550–1800*, ed. J. S. Cockburn (Princeton, 1977), pp. 37, 38.
77. Edward Waterhouse, *Fortescue Illustratus* (London, 1663), pp. 129, 259.
78. Hale, *History of the Common Law*, pp. 165, 167.
79. Macnair, "Fragment on Proof," p. 143.
80. Judge Vaughan in *State Trials*, VI, 1006.
81. *State Trials*, XXVI, 437, 457.
82. Cowell, *Interpreter*, s.v. "Jury."
83. Cockburn and Green, *Twelve Good Men and True*, pp. 377, 384, 385, 395, 397. See also pp. 129–130. London juries of the late seventeenth century were of higher status than provincial jurors. Ibid., p. 385.
84. Jurors were "such Persons as for Estate and Quality are fit to serve upon that Employment" and "of sufficient Freeholds, according to several Provisions of Acts of Parliament." Hale, *History of the Common Law*, pp. 160, 161.
85. William Walwyn, *Juries Justified* (London, 1650), pp. 4–5; Green, *Verdict According to Conscience*, p. 188. Some Interregnum reformers were hostile to juries. Donald Veall, *The Popular Movement for Law Reform* (Oxford, 1970), p. 117. The Hale Commission advocated literate jurors "of honest lives and conversations" and "good understanding."
86. See Cockburn, *History of the English Assizes*, pp. 118–120, 223, 331–332. See Waterhouse, *Fortescue*, p. 343; *Enchiridium Legum* (London, 1673), pp. 112, 114. *Commons Journals*, VIII, 610, 611, 613. Prosperous copyholders avoided jury duty by taking two-thousand-year leases. Anchitell Grey, *Debates of the House of Commons from 1667 to 1694* (London, 1763), I, 226.
87. Howell, *State Trials*, I, 52; *An Exact Account of the Trials . . . in the Old-Bailey . . . December 11, 1678* (London, 1678), p.31; Richard Bernard, *Guide to Grand Jury Men in Cases of Witchcraft* (London, 1627), p. 25.
88. Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, 1994).
89. Cockburn, *History of the English Assizes*, pp. 104–105.
90. Quoted in Shapin, *Social History of Truth*, pp. 69, 69n, from William Segar, *Honor Military and Civil*, p. 229.
91. Those of profligate or "wicked temper or disposition" had diminished credit. And only if it was thought that a man's "bias is so strong upon him, as would incline a man of his disposition, figure, and rank in the world to falsify, you are to disbelieve him." Witness credibility was related one's "state and dignity in the world, for men of easy circumstances are supposed" less likely to commit perjury. At the same time, the testimony of "every plain and honest man affirming the truth" under oath is entitled to faith and credit. Gilbert, *Law of Evidence*, pp. 149, 155. St. Germain in the early sixteenth century also insisted witnesses were assumed to be "honest, good and indifferent, till the contrary was shown." Quoted in More, *Works*, X, 157.
92. See Lorraine Daston, "Baconian Facts, Academic Civility, and the Prehistory of Objectivity," *Annals of Scholarship* 8(1991), 338, 339; Shapin, *Social History of Truth*. But see Barbara Shapiro, "Science and Religion in Seventeenth-Century England," *Past and Present* 40 (1968), 16–41; Barbara Shapiro, "Early Modern Intellectual Life: Humanism, Religion, and Science in Seventeenth-Century England," *History of Science* 29 (1991), 45–71.
93. Hale, *History of the Common Law*, pp. 161, 162–163; Howell, *State Trials*, I, 897.
94. Howell, *State Trials*, I, 887. See also Richard Helmholz, "Canonists and Standards of Impartiality for Papal Judges Delegate," *Traditio* 25 (1969), 386–404.
95. Wilfred Prest, "William Lambarde, Elizabethan Law Reform, and Early Stuart Politics," *Journal of British Studies* 34 (1995), 465–466; Coke, *Third Part of the Institutes*, p. 29. See also Michael Dalton, *The Country Justice* (London, 1618), pp. 4–5.
96. *An Exact Account of The Trial between Sir William Pritchard . . . and Thomas Papillon* (Lon-

don, 1682), p. 25. See also T. S., *A Sermon Preached at the Assizes* (London, 1689), pp. 15, 19, 22, 24.
97. Hale, *History of the Common Law*, p. 163.
98. Coke, *Third Part of the Institutes*, p. 29.
99. Maija Jansson, "Matthew Hale on Judges and Judging," *Journal of Legal History* 9 (1989), 204, 206, 207. See also Gilbert Burnet, *Life of Hale* (London, 1833), p. 101.
100. Isaac Barrow, *Works*, 3 vols. (London, 1687), II, 28.
101. Hale, *History of the Common Law*, p. 165. Judge North wrote "in matters of Fact" a judge might aid jurors "by weighing the Evidence before them" and showing "his Opinion." Macnair, "Fragment on Proof," p. 144. Thomas Fuller, not a lawyer, insisted that although juries might need guidance in matters of law, they "need not be led by the nose in matter of fact." Quoted in Cockburn and Green, *Twelve Good Men and True*, p. 146.
102. See John H. Langbein, "The Criminal Trial before the Lawyers," *University of Chicago Law Review* 45 (1978), 263–306; John H. Langbein, "Shaping the Eighteenth-Century Criminal Trial; A View from the Ryder Sources," *University of Chicago Law Review* 50 (1983), 1–136; Cockburn, *History of the English Assizes*, pp. 109, 110, 122–123; Macnair, "Fragment on Proof," pp. 143–148.
103. Hale, *History of the Common Law*, p. 165; Hale, *History of the Pleas of the Crown*, 2 vols. (London, 1800), II, 312–314. See also S. E., *Tryals per Pais* (London, 1685), p. 75.
104. Hale, *History of the Pleas of the Crown*, 1800, II, 314. If judges, agents of the central authority, were deemed better fact evaluators, local lay juries would become unnecessary.
105. Quoted in Jansson, "Hale," pp. 206–207.
106. See D. A. Rubini, "The Precarious Independence of the Judiciary, 1688–1701," *Law Quarterly Review* 83 (1967), 343–355.
107. Hale, *Primitive Origination*, p. 128.
108. Gilbert, *Law of Evidence*, pp. 122, 155.
109. See Oldham, "Truth Telling," pp. 110–111. The prohibition of interested parties resulted in elaborate documentation that included as much circumstantial material as possible as a hedge against future legal problems.
110. Howell, *State Trials*, I, 872.
111. William Prest, "Elizabethan Law Reform and Early Stuart Politics," *Journal of British Studies* 34 (1995), 468–469. See also Hobbes, *Leviathan*, p. 209; Gilbert Burnet, *Lives, Characters, and an address to Posterity* (London, 1833), p. 127; Barrow, *Works*, II, 28.
112. Sir John Hawles, *The Englishman's Right* (London, 1680), pp. 120, 127; [Sir George Berkeley], *Historical Applications* (London, 1690), pp. 61–62. For praise of elegant speeches, see S. E., *Tryals per Pais*, preface.
113. Although we have sometimes spoken as if jury trials took place in "courtrooms," such structures did not exist. Jury trials took place in a wide variety of physical settings.
114. Gilbert, *Law of Evidence*, pp. 2, 4.

Chapter 2: "Fact" and History

1. See *Henry IV*, IV.i.48; *Timon of Athens*, III.v.25; *The Rape of Lucrece*, 346. I owe these references to Michael Witmore. See also Ben Jonson, *Volpone*, V.vii.155.
2. See Arnaldo Momigliano, *Classical Foundations of Modern Historiography* (Berkeley, 1990); Donald Kelley, "The Theory of History," in *Cambridge History of Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (Cambridge, 1988), pp. 746–762.
3. Sidney, Bacon, and Hobbes associated history with sense and memory and poetry with the imagination. See William Nelson, *Fact or Fiction: The Dilemma of the Renaissance Storyteller* (Cambridge, Mass., 1973).
4. Cicero, *De oratore*, II, 62–64; IX, 36.
5. Cicero, *Brutus*, X, 42. See also Quintilian, *Institutio oratoria*, III, viii, 66; X, i, 31.
6. Beatrice Reynolds, "Shifting Currents in Historical Criticism," in *Renaissance Essays*, ed. P. O. Kristeller and P. P. Wiener (New York, 1968), pp. 115–136; George Nadel, "The Phi-

losophy of History before Historicism," *History and Theory* 3 (1963), 298–99, 302; Arno Seifert, *Cognitio Historica: Die Geschichte als Namengeberin der frühneuzeitlichen Empire* (Berlin, 1976).

7. See Timothy Hampton, *Writing from History: The Rhetoric of Exemplarity* (Ithaca, 1990).

8. Donald Kelley, *Foundations of Modern Historical Scholarship: Language, Law, and History in the French Renaissance* (New York, 1970), pp. 120, 121, 132; Julian Franklin, *Jean Bodin and the Sixteenth-Century Revolution in the Methodology of Law and History* (New York, 1963), pp. 129–129; George Huppert, *The Idea of Perfect History: Historical Erudition and Historical Philosophy in Renaissance France* (Urbana, Ill., 1970). See also Seifert, *Cognitio Historica.*

9. Huppert, *Perfect History*, pp. 24, 31, 34, 50, 62–63.

10. Franklin, *Bodin*, pp. 128, 129, 137, 139n, 140–146, 150. Jean Bodin, *Method for the Easy Comprehension of History*, trans. Beatrice Reynolds (New York, 1945), pp. 13, 50.

11. Thomas Blundeville, *The True Order and Method of Writing and Reading Hystories*, ed. H. G. Dick, *Huntington Library Quarterly* 3 (1939–40), 157.

12. Wilfred Prest, *The Rise of the Barristers: A Social History of the English Bar, 1590–1640* (Oxford, 1986), p. 200.

13. Linda Van Norden, "The Elizabethan College of Antiquaries" (Ph.D. dissertation, University of California, Los Angeles, 1946), pp. 334, 333, 349, 391, 393, 403. See also Joan Evans, *A History of the Society of Antiquaries* (Oxford, 1956). Sir Edward Coke, however, advised men to be beware when laws were "delivered by historians," and Roger Twysden thought law delivered by historians is "much differing from that [which] comes from a lawyer, as declaring not only the fact, but the policy, reason, and matter of state in it, where the other resolved onely how it stood with the law." Twysden, *Certain Considerations upon the Government of England* (London, 1849), p. 23.

14. David Berkowitz, *John Selden's Formative Years* (Washington, D.C., 1988), p. 43; H. D. Hazeltine, "Selden as a Legal Historian," *Harvard Law Review* 47 (1932), 12–20. See also F. Frank Fussner, *The Historical Revolution: English Historical Writing and Thought, 1580–1640* (London, 1962), p. 286; D. R. Woolf, *The Idea of History in Early Stuart England* (Toronto, 1990), pp. 200–242.

15. See Barbara J. Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983), pp. 119–193.

16. Thomas Hobbes, *Leviathan* (New York, 1975), p. 40.

17. See L. F. Dean, "Sir Francis Bacon's Theory of Civil History Writing," *ELH* 8 (1941), 161–165; G. H. Nadel, "History as Psychology in Francis Bacon's Theory of History," in *Essential Articles for the Study of Bacon*, ed. Brian Vickers (Hamden, Conn., 1968), pp. 236–252; Arthur B. Ferguson, "The Non-political Past in Bacon's Theory of History," *Journal of British Studies* 14 (1974), 4–20; Fussner, *Historical Revolution*, pp. 159–190.

18. Lord Bolingbroke, *Historical Writings*, ed. Isaac Kramnick (Chicago, 1972), pp. 4, 5, 8, 9, 10, 69.

19. White Kennett, *General History*, preface; Edmund Calamy, *A Letter to . . . Echard* (London, 1718), p. 6.

20. Gilbert Burnet, *Memoires of . . . James and William, Dukes of Hamilton* (London, 1677), preface.

21. Ludlow's were "based on personal experience" and what he learned from "persons well informed and of unsuspected fidelity." Edmund Ludlow, *Memoirs*, ed. C. H. Firth, 2 vols. (Oxford, 1891), I, 7. Denzil Holles, *Memoirs* (London, 1699), Preface to the Reader. Clarendon's "History" was sometimes considered a memoir. *Mr. Le Clerc's Account of the Earl of Clarendon's History of the Civil Wars* (London, 1710), p. 7.

22. William Dugdale, *Memorials of the English Affairs* (London, 1682), Publisher to the Reader.

23. Bulstrode Whitelocke, *Memorials of the English Affairs or an Historical Account* (London, 1682), Publisher to the Reader.

24. William Camden, *Britannia*, 1695 ed., s.v. "Life of Camden." See also David Lloyd, *Memorials* (London, 1668), preface; Holles, *Memoirs*, Publisher to the Reader, ix.

news comes from an uncertain Author, though probable and expected, yet suspend your belief: because men easily report what they desire to expect; but rather give heed to certain extravagant and unexpected Relations, as unlikelier to be invented."[82] Here the plausible and the expected were suspect, and the "extravagant and unexpected" more believable. If the reverse was more often thought to be appropriate, it was still difficult to find any completely satisfactory standard of belief in "factual reports," even those allegedly supported by respectable and experienced witnesses.

Conclusion

The news media, which began at the end of the sixteenth century and flourished in the seventeenth and eighteenth, played a vital part in the development of the discourses of fact. They purveyed a kind of culture of facts to a relatively wide range of Englishmen. Midcentury circumstances of civil war and political turmoil stimulated the desire for political and military "facts." The period from 1640 to 1660 thus had a significant role in the acculturation of the concept of fact. The news media, especially after the Restoration, treated both human affairs and natural phenomena as facts, thus fostering the shift of "fact" from the older legal and historical meaning of human deed to a newer, more encompassing meaning. They bolstered the concern for verifiability through such techniques as multiple witnessing that are to be found in the other discourses of fact. They linked the public more closely with the concerns of historians and lawyers. They reiterated the norm of impartiality. And, particularly in their treatment of the marvelous, the news media took the public into the realm of empirical verification, which concerned both theologians and natural philosophers.

CHAPTER FIVE

The Facts of Nature I

Despite the common early use of "fact" in law, historio
raphy, and news reporting, the concept is now most c
ten associated with natural science. Indeed, the conce
"fact" has become so closely identified with science that it is often assum
this association has always existed. Yet in England the concept "fact" h
its principal origin in law and was initially limited to human actions a
events. Only later would it acquire its association with a "true statemer
about the natural world.

Until quite recently, the constituent concepts of early modern natu
philosophy, concepts such as "experiment," "experience," "fact," "hypo
esis," "theory," "cause," "probability," and the "laws of nature," have
been a central concern.[1] That situation is now changing. The pioneeri
work of Steven Shapin and Simon Schaffer on the conceptual elements
the competing natural philosophies of Robert Boyle and Thomas Hobb
has shown that "matter of fact" played a central role in the construction
Boyle's natural philosophy. Their work, to which we frequently make r
erence here, is characterized by a contextualism that focuses on sho
term and localized English conditions and, therefore, does not concern
self with how "fact" or "matter of fact" evolved or was related to ou
intellectual traditions at home or abroad. Shapin's more recent work
sociates scientific fact finding with the social categories "courtier" a
"gentleman." It takes a longer view but also ignores related traditi

which pose major difficulties for the gentleman hypothesis. Peter Dear has described the subtle but crucial differences between "experience" and "experiment" in the work of certain late scholastic natural philosophers in the mathematico-physical tradition and in the empirical experimentalism of the Royal Society. Katherine Park and Lorraine Daston have connected the origin of the natural fact with descriptions of marvels and monsters. Like Dear, they contrast the "common experience" of traditional natural philosophy with the particularized "fact" of the natural historians and experimentalists of seventeenth-century England.[2]

The historical understanding of the concept "fact" has been somewhat obscured by Vico's "*verum-factum*," which expressed a distinction between the unknowable world that God made and the world human beings have made, which is knowable because they have made it. Paolo Rossi has utilized Vico's categories not to underline the differences between natural knowledge and human knowledge but to suggest the gradual acceptance of new ways of thinking about "knowing" and "doing," with respect to the natural world, in the work of magicians, alchemists, Paracelsians, and hermeticists. He emphasizes Francis Bacon's indebtedness to the tradition that connects making and doing, theory and practice, art and nature. Bacon's role in the human construction of natural knowledge is developed further by Antonio Perez-Ramos. Current emphasis on natural knowledge as a human construction runs counter to intellectual traditions that separate knowledge of the natural world and the world of human making.[3]

My treatment of the creation or construction of the "scientific fact" is both related to and somewhat different from this body of scholarship. It takes a longer chronological perspective and relates the "facts" of natural philosophy to a group of contemporary discourses that already had adopted, or were simultaneously adopting, the concept "fact." In this chapter I attempt to show how the legal concept "fact" or "matter of fact," which dealt with past human acts, was adopted and then adapted by natural historians and experimentalists to suit the new emphasis on observation of particular natural phenomena. Although my study does not emphasize the constructivist elements in the making of English natural philosophy, it should shed some light on the early modern mixtures of "understanding" and "doing" posited by Rossi, Perez-Ramos, and Hans Blumenberg.

The distinction between *verum* and *factum*, or the distinction between the work of God and the works of man, was a commonplace in the early modern world.[4] In this conceptualization of knowledge, natural phenomena were not handled under the rubric of "fact" or "factum," terms attached to the works of man. The innovation of Francis Bacon and his successors was to apply the techniques and conceptions developed to deal with human deeds to natural phenomena, that is, to the works of God and

natural phenomena "made" by humans. Over time, the testimony of witnesses became crucial to establishing knowledge of natural phenomena, whether ordinary, unusual, marvelous, or experimental. With the introduction of "fact" into the realm of natural history and experimental philosophy, the distinction between *verum* and *factum* is eroded and the methodologies for establishing and verifying human actions and natural phenomena become almost, if not completely, identical. It is that process that we trace in this chapter.

The most prominent strand of English natural philosophy became a philosophy based on "fact," or, as contemporaries would have labeled it, "matter of fact." The English emphasis on "matter of fact," and efforts to link fact and hypothesis, gave English natural philosophy its most distinctive features. Although there was no unanimity within the English scientific community, and some comparable developments occurred elsewhere, the English scientific program and practice as exemplified in the work of the Royal Society was distinctive. A significant part of its distinctiveness resulted from its initial enthusiasm for the Baconian program of natural history and experiment grounded on well-proved "facts." The twin concepts "fact" and "hypothesis" proved central to the natural philosophy that came to characterize the Royal Society, the visible symbol of English natural philosophy during the late seventeenth century.

Francis Bacon and the "Facts" of Nature

Francis Bacon was a central agent in the transformation of "fact" from human to natural phenomena. Bacon not only insisted that properly verified "matters of fact" provided the foundation for natural philosophy but also extended natural history to include experiment. Of course, the translation of "fact" from human to natural phenomena was not achieved exclusively by Bacon's efforts. We have already examined the process by which cosmographers and topographers began to treat both human and natural objects and events as "matters of fact" and how unusual natural events were beginning to be somewhat similarly treated. The growing popularity of Baconian natural history, however, underlined the possibility and desirability of treating both natural and human history as rooted in "matters of fact" observed and recorded. Bacon is also central to the creation of the "experimental fact." Human agents created artificial, that is, humanly constructed natural events that could be observed and recorded just as were such ordinary and wondrous natural events or objects as comets, plants, and birds.

For Bacon, observations and experiments were to yield the "facts" that would be used to construct a new natural philosophy to succeed that of Aristotle. Aristotelian "experience" did not refer to a particular experience

or to observations that occurred at particular times and places. Aristotelianism also maintained a clear distinction between nature and art. Thus, it was only with some difficulty that constructed experiments were incorporated into Aristotelian natural philosophy.[5]

Bacon was ideally situated to appropriate legal-historical methods to the cause of natural philosophy. He was an important legal practitioner and judge, familiar with common and civil law procedures as well as the hybrid procedure of Chancery over which he presided. He was a self-conscious reformer of *both* jurisprudence and natural philosophy as well as a historian. I am, of course, hardly the first to suggest the general connection between Bacon's legal thought and his natural philosophy.[6] My concern is not with the overall indebtedness of Bacon's science to law but with the particular origins and functions of "matter of fact" in his natural philosophy.

History, for Bacon, was divided into the two familiar varieties. Natural history "treats of the deeds and works of Nature, civil history those of men." The "deeds and works" of both were concerned with particulars "circumscribed by time and place."[7] Bacon found the current state of natural history deplorable. He castigated the traditional reliance on experience in which "rumour and vague fames" or the "gossip of the streets" were "allowed the weight of lawful evidence." Nothing was "duly investigated, nothing verified, nothing counted, weighed or measured."[8] His predecessors had given only a "glance or two upon facts and examples and experience" before invoking "their own spirits to give them oracles." "Dwelling purely and constantly among the facts of nature," Bacon would begin the program anew.[9]

Baconian natural history was to break from the Renaissance tradition of natural history, a tradition aptly characterized as an "emblematic world view" in which a mélange of symbols, correspondences, observations, proverbs, and fables formed a complex web of verbal and natural associations.[10] The breakdown of this tradition, facilitated and partly caused by the discovery of previously unknown New World species of flora and fauna, was dramatically embraced by Bacon, whose new natural philosophy was to be built on natural histories expunged of literary, mythical, and symbolic elements. Natural history, still neglected by scholars, would be reconstructed so that it would be based on well-established "facts," not literary allusion or traditional lore.[11]

The new Baconian natural history was to be compiled with "religious care, as if every particular were stated upon an oath."[12] Although initial information was provided by the senses, observations had to be sifted and examined in a variety of ways to discover error. Bacon warned that the "testimony and information of the sense has reference always to man, not to the universe, and it is a great error to assert that the sense is the measure

of things." Yet, as in law, eyewitness testimony takes pride of place. Experiments would play a crucial role, being, Bacon thought, more subtle than immediate sense observation.[13] All depended on keeping the eye steadily fixed on the "facts of nature."[14] "Matters of fact," broadened by Bacon to include virtually all natural phenomena either observed or created experimentally, were to provide the basis for what he felt to be an entirely new natural philosophy.

Although Bacon recognized that there were dangers connected with "wonders," he nevertheless wished to record the unusual, the anomalous, and the accidental.[15] He also expanded the scope of traditional natural history by proposing that well-certified histories of trades be compiled. These, like experimental histories, combined natural materials and human intervention and construction. The credit of things both ordinary and anomalous must be evaluated as "certainly true, doubtful whether true or not, certainly not true." The doubtful must be reported in such tentative phrases as "it is reported," "they relate," or "I have heard from a person of credit," phraseology reminiscent of the news media. In important instances "the name of the author should be given, and not the name merely, but it should be mentioned withal whether he took it from report, oral or written, . . . or rather affirmed it of his own knowledge; also whether it was a thing which happened in his own time or earlier; and again whether it was a thing of which, if it really happened, there must needs have been many witnesses; and finally whether the author was a vain-speaking and light person or sober and severe; and the like points, which bear on the weight of the evidence."[16] These criteria, already part of the legal and historiographical traditions, would also become central to empirically based natural philosophy.

Bacon occasionally employed the phrase "the Facts of Nature" and he believed such facts could be firmly established.[17] Although natural history, or the "Facts of Nature," would "give light to the discovery of causes," it did not deal with causes.[18] Only after the facts and experiments were properly verified and recorded, with the same or perhaps even greater certainty than facts in the courtroom, would the *New Organon*, itself derived at least in part from legal interrogatories, be implemented by sophisticated professionals.[19] If Bacon's goal of acquiring knowledge of the Forms left him an essentialist at heart, the empirical foundation on which that essentialism was to be built was itself grounded in the nonessentialist traditions of legal fact determination.

Bacon's combination of the historico-legal "fact" of human action with the natural fact established by observation and experiment made it possible for his successors to apply a familiar legal technique of verifying events in the human world to natural phenomena. In natural history as in law, "matter of fact" could best be established by the testimony of a

sufficient number of firsthand witnesses of appropriate credibility. The term "fact" or "matter of fact" implied, for most of the seventeenth century, not something already worthy of belief or true but rather a matter capable of proof, preferably by multiple eyewitness testimony.

The creation of the natural and experimental "fact" was, of course, only one component in the complex series of intellectual developments conventionally labeled the "scientific revolution." Nor was Bacon always first. Ancient and Renaissance astronomers had described seemingly singular nonrepeatable events long before Bacon, and those working in the alchemical tradition also employed witnesses.[20] If English natural philosophy of the seventeenth century contained important Baconian strands, it cannot simply be equated with Baconianism. However much the virtuosi of the Royal Society condemned Descartes for dogmatism and system making and scholastic Aristotelians for their outmoded and useless notions, a good many English virtuosi incorporated elements of Cartesianism or retained Aristotelian concepts. Many developments in mathematics, physics, astronomy, anatomy, and medicine can be explained with little or no reference to the Baconian program. Yet the innovative Baconian transformation of "fact" from the realms of law and history where human agents were exclusively involved to natural history and natural philosophy was crucial to the development of the natural and later "scientific fact."

While the scientific revolution is often characterized as occurring primarily in the realm of astronomy and physics, the bulk of activities carried on by the English scientific community during the decades following Bacon's death focused on natural history composed of "facts" derived from observation and experiment. By the mid-seventeenth century the combined influence of the Baconian appropriation of "fact" to natural history and the development of chorographic-intertwined descriptions of human and natural phenomena permitted the English to use the term "fact" or "matter of fact" in connection with both natural and civil history.

Thomas Hobbes, no admirer of the natural philosophy that would be developed by the Royal Society, thus treated natural history as "fact." For Hobbes, "the register of Knowledge of Fact is called History." Natural history was "the History of such Facts, or Effects of Nature . . . Such as the Histories of Metalls, Plants, Animals, Regions and the like. The other is Civil History, which [is] the History of the Voluntary Actions of Men in Commonwealths."[21] In both varieties "fact" was derived from "sense and memory" and characterized as "the knowledge required in a witness."[22] For Hobbes, however, "scientific" knowledge was dependent on reason, not observation or experiment, and his philosophic model was self-consciously borrowed from geometry, not the fact-establishing methods of the law. Hobbes's association of "fact" with the traditional language of the "effects of nature" is significant because this association facilitated the

ability of empirically minded naturalists to assimilate the emphasis on particular events and experimental observations to established linguistic conventions of natural philosophy.[23]

The decades between Bacon and the founding of the Royal Society witnessed the physiological investigations of William Harvey, whose work combined traditional medical assumptions with the importance of firsthand sense observation. Harvey too adopted legal phraseology when he spoke of the "right verdict of the senses controlled by frequent observations and valid experiences" and called upon his readers to take nothing he said on trust. Their eyes would be his "witnesses" and "judges."[24]

Natural history based on careful observation and experiment in the Baconian and Harvean modes thus became the dominant, albeit not the exclusive, form of English scientific inquiry in the generations following Bacon's death. Some aspects of the new philosophy utilized experiment, without assuming that the principles of natural philosophy necessarily would be built on the foundation of natural history or natural "matters of fact." Although Bacon's natural philosophy did not easily incorporate mathematics, several Restoration naturalists would combine mathematics with observation and experiment. "Fact" and experiment would also be deployed by alchemical, chemical, and vitalist natural philosophers as well as mechanical ones.[25]

We use the term "empirical natural philosophy" to include both those who felt that a true knowledge of causes could be derived from observed "facts" and those who felt that causal explanations would always remain probable or hypothetical. Well-observed and experimentally produced "facts" would become central to both schools of thought. It was the shift in investigations of nature to the particular firsthand observation, that is, to natural and experimental history, that brought natural phenomena into the orbit of "fact."

While our attention will be focused largely on the Royal Society, we should take note of the civil war and Interregnum decades, when some Baconians were linked to millenarian and other projects and others were pursued by a group of scholars centered at Wadham College, Oxford. Although there was some overlap, Puritan projectors and educational and social reformers centered around Samuel Hartlib represent one strand of Baconian thought, and the efforts of the Oxford group, another. Many of the future leaders of the Royal Society gathered around John Wilkins, the warden of Wadham College, who was described as the "principall Reviver of Experimental Philosophy (secundum mentem Domini Bacon)." Here Wilkins, Seth Ward, John Wallis, William Neile, Ralph Bathurst, Jonathan Goddard, John Evelyn, Christopher and Matthew Wren, Thomas Willis, William Petty, and latecomers Robert Boyle and Robert Hooke pursued a wide variety of Baconian and non-Baconian projects orchestrated by

Wilkins. This "Embryo or First Conception of the Royal Society," which overlapped with the Oxford Harvean physiologists, engaged in astronomy, medical experiment, mathematical theorizing, practical inventions, and chemical experiments, without providing a public statement of their methods and goals. Seeking relief from the political and religious turmoil of the times, they worked quietly and privately until they again joined forces with their London-based Gresham College colleagues and returning Royalist exile virtuosi to form the Royal Society. Much work published in the early years of the Restoration was the fruit of Interregnum research.[26]

Matters of Fact and the Research Program of the Royal Society

Observed and experimentally produced "matters of fact" became central to the research agenda of the Royal Society. Like legal facts, "scientific facts" were established primarily by witnesses whose testimony would be evaluated on the basis of a set of legally derived criteria of credibility, such as opportunity, ability, probity, skill, fidelity, status, experience, and reputation. As we have seen, common law decisions on matters of fact were placed in the hands of lay jurors whose middling socioeconomic standing was deemed sufficient to render them capable of independent impartial decisions on matters of fact. We have also seen that similar criteria were invoked by historians to favor the testimony of politically experienced firsthand observers. These models, taken over by the naturalists when they adopted the concept of matter of fact, help explain the law-laden language of the virtuosi and their emphasis on witnessing, impartiality, and cautiousness about going beyond well-proved facts. Widespread previous familiarity in other disciplinary realms also helps explain why we find no justification or explanation by the virtuosi of their adoption of the usage "fact."

Apologists and Spokesmen: Thomas Sprat, Joseph Glanvill, and Henry Oldenburg

Given their importance in communicating the research program and aspirations of the Royal Society, we begin with Thomas Sprat's and Joseph Glanvill's attempts to publicize and defend the Society and with Henry Oldenburg's vast correspondence undertaken as secretary of the Royal Society and his *Philosophical Transactions*. All three men insisted on observation and experiment as the core of the Society's early agenda. The "New" or "Experimental Philosophy" was described by Sprat as grounded on "matter of fact," that is, on a natural history based on observation and experiment. At one point Sprat suggested, with some exaggeration to be

sure, that members of the Royal Society "only deal in matters of Fact." The Society preferred its "own Touch and Sight," privileging firsthand reports provided by the senses over hearsay or secondhand experience. Where firsthand observation was lacking, the Society, like the historian, was "forced to trust the reports of others." Sprat described the Royal Society's primary activity as "Directing, Judging, Conjecturing, Improving and Discoursing upon Experiments," with judgments to be based on "the matter of fact and repeated experiments." Witnessing by substantial numbers would give credence to the experiment observed, Sprat emphasizing in this connection that judgments on matters of fact coming before the Royal Society would be based on the "concurring testimonies" of its members: "In almost all other matters of Belief, or Opinion, or of Science: the assurance is nothing near so firm as this." Because membership ranged from about sixty to one hundred, conditions for reaching moral certitude were far better than in the law courts, where the testimony of two or three witnesses was sufficient in judgments on matters of life or estate. Sprat characterized members as impartial judges before whom reports were given and experiments made. Jury-like, they accepted or rejected proposed "matters of fact."[27]

Reports were to emphasize the firsthand observation and experience of the speaker, who typically used the first person as a means of giving credibility to the discrete occurrences described.[28] The use of the first-person active voice was precisely what was required of a witness describing an event to a jury or judge and was the preferred mode of the memoirist, chorographer, and traveler.

Joseph Glanvill, after Sprat perhaps the most vocal apologist for the Royal Society, also employed the terminology of "matter of fact" to describe the methods and procedures of the virtuosi. The Royal Society dealt with the "plain Objects of Sense" because it was in these, "if anywhere, there might be found Certainty." Similar certainty might arise from testimony, which under the best circumstances also provided "undubitable assent." These conditions were met when reporters were disinterested, their reports full, and acceptance general. Such reporters were to be found in the Royal Society, whose members were men of "wit and Fortune . . . where fondness of preconceived opinions, sordid Interests, or affectation of strange Relations, are not like to render . . . reports suspect or partial, nor want of Sagacity, Fortune, or Care, defective." The reports of their "Tryals" might thus be received as "undoubted Records of certain events." While error was always possible, "matters of fact well proved ought not be denied." It was necessary, of course, to proportion assent to the "degree of the evidence" and to be confident "only in those distinctly and clearly apprehended."[29] Like the common law jury, the Royal Society could determine the truth of "matters of fact."

Like lawyers and historians, Sprat and Glanvill distinguished between

"matters of fact" and explanations or causes of those facts. Glanvill observed that, even if derived from careful observation of particulars, the best principles of natural knowledge remained "but hypotheses." Without the history of nature, "our Hypotheses are but Dreams and Romances, and our Science mere conjecture and opinion."[30]

Henry Oldenburg provided official statements of the Royal Society's goals and methods in his correspondence with domestic and foreign virtuosi and in his private periodical venture, the *Philosophical Transactions*. Oldenburg referred to the task of building a new natural philosophy from "a large and truthful natural history" obtained by "observing carefully and faithfully and exactly passing on whatever" was observed. Such a "faithful History" would "comprehend a competent stock of observations and Experiments, carefully made." This was a cooperative enterprise to be jointly undertaken by Society members and "the most philosophicall and curious persons" from "all parts of ye world." "Ingenious conceptions and philosophical matter of fact" contributed by the "learned and inquiring of the world" were crucial. After "comparing and considering" observations and experiments "all together," the Royal Society hoped to raise "a body of natural Philosophy, as may give a rational account of ye effects of nature." "Facts" thus were essential but not the final goal.[31] Like Sprat and Glanvill, Oldenburg used the phrase "matter of fact" easily without explaining its meaning or its rather novel application to physical phenomena. Presumably, the concept was already sufficiently familiar to their readers.[32]

If some scholars now reject the notion of a single scientific ideology characterizing the Royal Society,[33] its chief apologists and public spokesmen adopted a Baconian rhetoric of cooperative collection of "matters of fact" derived from careful observation and experiment. They anticipated that the resulting natural histories in time might result in natural philosophy. The collection and production of "matters of fact" was in many respects the enterprise that held the Society and its correspondents together, however much members might differ on the best means of dealing with or interpreting the "facts."

Natural History

For many years, Thomas Kuhn and Andre Koyre have accustomed us to think of the "scientific revolution" in terms of astronomy and physics. Historians have, therefore, underestimated the extent to which the Royal Society was devoted to "natural history," a term that currently has a more circumscribed meaning than it had in the seventeenth century. For most members of the Royal Society, the "new philosophy" would be grounded on a new and faithfully constructed natural history, that is, a collection of well-established "matters of fact," sometimes created experi-

mentally, and personally observed or credibly reported. The range of what was to be covered by this natural history was enormous. Both Hooke's astronomical observations and Hevelius's *Selenographia* were treated as natural history. Natural history included topography, geology, climatology, botany, zoology, anatomy, and chemistry as well as human customs, manners, governmental structures, and trades. Virtually all the chorographical topics were included under the umbrella of natural history. But natural history also included aspects of physiology, anatomy, and medicine. All natural objects, occurrences, or experimental results capable of being observed might be "matters of fact" and thus part of natural history. These "facts" then might be utilized by those who adopted mechanical, atomist, vitalistic, or alchemical natural philosophies.[34]

Although one is not likely to think of Robert Hooke as a natural historian, natural history in the broadly conceived seventeenth-century sense was central to his conception of natural philosophy. Carefully observed information was to be transcribed in a special record book while still fresh in mind. Not every kind of observation and experiment would do, nor was "every observator fitt to be a collector." "Observations not rightly and accurately made" were "pernicious and Destructive" like "a rotten beam in a large edifice." The philosophical historian must be taught "what he ought to observe, how to examine it, how to preserve & and register it, How to range and order it." Ideally, this work was to be done by "a society of men . . . as have an eminency both of Parts and Fortune, & of such as have a will as well as abilities."[35]

Natural history for Hooke comprised "all kinds of Naturall and artificiall bodies and all kinds of Naturall and artificial motions or actions." Some were so obvious that they could not "scape the most negligent observer, others soe abstruse and hidden that they may elude the endeavors of the most Diligent inquirer." Experiment too was required. The philosophical historian "should Indeavour to be knowing & versed in all the various ways of examining & trying of matter or making experiments, trialls, . . . essayes on various kinds of substances."[36] Experiments should be "ranged in several orders of degrees: in every of which places they may stand like so many witnesses to give testimony of this truth or against that error. . . . And a most severe examination of these witnesses must be made before a jury can warrantably give their verdict or a judge pronounce sentence for branding one proposition or hypothesis as erroneous . . . or for establishing another for truth or axiom."[37] Although sense could not reach all of nature, there was no method as "certain and infallible," if "rightly and judiciously made use of." Not surprisingly, Hooke referred to his own experiments as "History and matter of Fact."[38]

As we have seen, Oldenburg solicited "matters of fact" from his worldwide correspondence network. "Matters of fact" were also solicited in the

Royal Society's queries of travelers. The term "matter of fact" also appeared frequently in connection with reports on particular aspects of natural history and in publications dealing with natural history topics as diverse as Humphrey Ridley's *Anatomy of the Brain* and Peter Wyche's description of the Nile. John Ray would "admit nothing for Matter of Fact or Experiment but what is undoubtedly true"; Francis Willughby's *Ornithology* would include only "particulars" that could be "warranted upon our knowledge and experience or where we have assurance by the testimony of Good Authors or sufficient Witnesses." John Evelyn employed "matter of fact" in connection with civil, geographical, and natural history; Martin Lister emphasized the importance of faithfully delivered "matters of fact"; and John Wallis referred to his experiments on Mercury as "matter of fact." In 1676 Isaac Newton wrote Oldenburg indicating that "the business" he was concerned with "being about matter of fact" was properly decided not by discussion but "by trying it before competent witnesses."[39]

The focus on fact continued into the latter part of the century as well, John Woodward claiming, "All parties so far agree" that "observations are the only sure Grounds . . . to build a lasting and substantial Philosophy." His natural history of the earth would, therefore, "be guided wholly by Matter of Fact; . . . [it is] of all hands to be the best and surest; and not to offer anything but what hath due warrant from observations; and those both carefully made, and faithfully related." Sir Hans Sloane, who succeeded Newton as president of the Royal Society, similarly asserted that "matters of fact" were the essentials of scientific knowledge and "that the Knowledge of Natural History, being Observations of Matter of Fact, is more certain than most Others . . . less subject to Mistake than Reasonings, Hypothesis and Deductions."[40] Yet many of these early modern invocations of "matters of fact" indicate that, as in law, facts remained in the realm of the provable rather than the proved. As Ray's statement suggests, not all facts were worthy of belief. Facts thus should be "candidly taken notice of and faithfully rectified or corrected."[41]

Robert Boyle

In recent years, Robert Boyle has become increasingly central to discussions of English natural philosophy, and several scholars have spotlighted his role as model virtuoso.[42] The most influential are Steven Shapin and Simon Schaffer. While noting Boyle's legalistic terminology relating to fact, they substantially underestimate the role of legal concepts not only in Boyle's natural philosophy but in shaping the epistemological foundations of English natural history and experimental science more generally. Placing Boyle's comments on witnessing, testimony, and matters of fact alongside those of his fellow virtuosi, we can see that Boyle's role in

creating and publicizing the concept "matter of fact" in English natural philosophy has been overemphasized. The crucial transition from human to natural fact was made by Bacon and the chorographers and was enhanced by additional writing in the vernacular. Had the majority of English naturalists continued to communicate about natural phenomena and experiment in Latin, it is less likely that "matter of fact" or "factum" would have become so commonly used to refer to natural events. It was the English virtuosi collectively who made that transformation a fundamental part of the "new philosophy."[43]

Like Bacon, Hooke, and others, Boyle held that "Natural history, . . . the only sure Foundation of Natural Philosophy,"[44] was based on "matter of fact," that is, particular experiments and specific "Observations faithfully made and deliver'd." "Matters of fact" provided Boyle the epistemological basis of his philosophy, and he frequently used legal metaphors to describe them. He referred at one point to the "Testimony of nature," analogizing nature to a witness. At another, he referred to "judicious and illustrious witnesses" and at yet another suggested that "matters of fact ought to be brought to trial."[45] Both his outlook and his language with respect to "matters of fact" were little different from those of his virtuosi colleagues.

Knowledge of "matter of fact" was, for Boyle, derived from the senses and communicated to others by means of testimony. Experience, "the knowledge we have of any Matter of Fact," might be personal, that is, based on one's own sensation; historical, that is, known by the relation or testimony of someone else; or theological, that is, known by revelation.[46] The knowledge of matters of fact included past and present, the human, the natural, and the divine.

Nowhere did Boyle or his Restoration contemporaries suggest that they are introducing a novel concept to natural philosophy. And how could they have done so, given the use of "fact" or "matter of fact" in so many different fields of endeavor? One of the things that made their new natural history so readily acceptable was that it was to be established by familiar and respected methods and criteria. These were so well known that there was no need for explanation or comment. Although new to "natural history" and "natural philosophy," the concept of fact and appropriate means of establishing matters of fact were not new to English audiences.

Witnessing

Witnessing was an essential part of establishing matters of fact, and participants in the discourses of fact were well aware that witnesses might vary in number and be more or less reliable. We have encountered the criteria for credible witnessing in several disciplines and genres and noted the concern of the Royal Society with ensuring that the inquiries it

pursued in distant locales were made by credible and well-qualified reporters. To the extent that the Royal Society cooperated with non-English observers, experimenters, and travelers, it enlarged the fact-gathering community far beyond the cluster of English virtuosi who resided in or near enough to London to participate in its experimental activities. Reliance on persons outside the London-Oxford community of investigators meant that nongentlemen and often relatively unknown reporters were deeply enmeshed in the Restoration fact-establishing network.

Although we often speak of the English scientific community as if it were one, there were in fact several involved in producing natural or scientific "matters of fact." Membership in some of these "fact"-establishing circles required little more than honesty, sharp eyes, and an ability to describe or illustrate what had been viewed. In others it required medical or anatomical knowledge, a sophisticated knowledge of mathematics and physics, chemical knowledge and experience, or familiarity with particular scientific instruments. Some members of each of these subcommunities might be personally known to the nucleus of Royal Society members, others would have been known only by reputation, and still others not at all before their initial reports.

While the "matters of fact" being assembled by the Royal Society were so various and came from so many different individuals and venues, some qualifications were considered necessary or desirable in all those who contributed observations and experimental reports. Shapin has argued that the social status of gentleman provided the necessary and sufficient guarantee of credibility. The criteria of credibility, however, were more specific and more varied and were substantially the same as those of the courtroom and the other contemporaneous realms of fact. Credibility was assessed on the basis of a range of considerations that included social status but also the experience, skill, fidelity, and impartiality of the observer and the number of supporting observers.

The social aspects of scientific witnessing have been recently highlighted by Shapin's attention to the issue of whose word was trustworthy in Restoration society and his contention that the model of aristocrat and gentleman was central in shaping the ideal type of "scientist."[47] In this connection we would do well to recall that social class *and* experience played a role in the legal arena and that opportunity for firsthand observation of the fact in question had a crucial role in creating legal credibility. The mere status of gentleman could hardly be decisive in the courtroom where one gentleman might well be contending against another and where witnesses of several classes might appear on both sides. I suggest that the scientific community adopted important elements of legal witnessing as constituent elements in the construction of the ideal scientific observer and reporter rather than relying on the courtier-aristocratic

model. To be sure, institutional and technological differences between the English legal system and English natural philosophy resulted in some differentiation in how the two disciplines attempted to verify "facts." We therefore point both to the virtuosi's adoption of the methods of legal fact determination and to modifications engendered by differing disciplinary circumstances.

Eyewitnesses and "Ocular" Testimony

In their search for well-established facts, virtuosi, like lawyers and judges, expressed the need for eyewitness testimony. They too preferred the visual over other senses, and well-established facts over inferences that might be drawn from them. And both expressed a distaste for, if not a complete rejection of, secondhand or hearsay evidence, although the naturalists, like historians and news reporters, also recognized that circumstances sometimes required them to rely on the reports of others when dealing with nonreplicable or far-distant events. In both law and natural philosophy, emphasis on the particular meant that the testimony of a reliable witness was the best evidence available.

If, unlike the courts, the Royal Society had neither the power nor the desire to compel the attendance of witnesses, reference to eyewitness testimony became a commonplace of the English naturalists. Boyle, for example, emphasized that "the bulk of the matters of fact I deliver should consist of things, whereof I was myself an actor or an eye-witness." Yet he recognized that he would often have to depend on the reports of others. In such instances he would believe only reports that had been delivered "upon" the author's "own particular knowledge, or with peculiar circumstances."[48] Robert Plot would mention only what he had "seen himself, or has received unquestionable Testimony for it." Walter Pope insisted he "would make no hearsays in this true relation." John Ray wished for "Assurances from Eye-witnesses of Credit," being "loath to put in anything on uncertain Rumour."[49] The uncertainty of rumor, hearsay, or common fame, as in the courts, was contrasted to eyewitness testimony. Rechecking a report of a "rain of wheat," the Royal Society asked the author to write the bailiff of the town, requesting the ministers and the physicians who had witnessed it to send a further account of the "matter of fact." Microscopic studies, Hooke insisted, required "a sincere Hand, and a faithful eye" to examine and record "the things themselves as they appear." Sir Matthew Hale favored a natural philosophy that began with the senses, which "examine particular Matters of fact, how they are, or fall out, search into Experiments and visible Trials."[50]

Recognizing that the Royal Society's policy of "receiving all credible accounts" might result in some "hazard, and uncertainty," Sprat argued

that this danger was removed because the Society reduced "such matters of hearsay and information, into real, and impartial Trials, perform'd by their Experiments," capable of "exactness, variation, and accurate repetition."[51]

Naturalists routinely referred to "ocularly manifest" observations or to "ocular demonstration[s] . . . of matter of fact."[52] Harvey's circulation of the blood, for example, was characterized as "an Ocular Demonstration." Royal Society members witnessed Valentine Greatrakes's inexplicable cures in order to "have an ocular Testimony of Truth" as "eyewitnesses of what was done." Sir Robert Moray consulted those who learned by "ocular inspection and Experiment or by the relation of trustworthy persons."[53]

Eager to expand its data base, and without the material interests of conflicting parties who were affected by what was "let in," the Royal Society was actually far less hostile to secondhand testimony than the courts. The Society often had to make do with reports that merely claimed to be based on eyewitness testimony. Yet emphasis on the eyewitness testimony behind the secondary reports reflects the same rejection of common knowledge. And, where possible, members sought to convert hearsay or single-witness testimony into a record established by multiple eyewitnesses. Experiments first done in private often would be repeated before the assembled members rather than simply reported to it. It is noteworthy that in such instances, where the Society might have relied on the word of gentlemen experimenters, it preferred eyewitness corroboration.

The Social Status of Witnesses: Travelers, Seamen, and Tradesmen

In considering the problem of scientific witnessing, we must refer to Chapter 3's description of the Royal Society's efforts to obtain natural history materials from all over the world. Because members were unlikely to be found in all the desired venues, Oldenburg solicited reports from English diplomats, travelers, virtuosi, sea captains, and ordinary seamen, emphasizing that the Society drew on the "learned and skillful in every country" to assist in establishing "a true history of nature."[54] John Winthrop of Massachusetts was asked to contribute not only the "Observables" made by his own "ingenuity, experience and veracity" but also what he might "learne from observing and credible navigators." Moray requested of the duke of York that all ships be required to make observations and perform experiments for Society use. Hooke referred to the reports of Erasmus Bartholine, "a person of known Abilitys in Mathematical and Physical Learning," and noted that Bartholine and Picart "wanted neither skill nor Instruments." Edmund Halley's account of the trade winds relied

on navigators and others "acquainted with all parts of India, and having liv'd a considerable Time between the Tropickes."[55] In these instances knowledge and experience counted for more than social status.

The Royal Society thus depended both on well-known and trusted individuals and on unfamiliar persons whose credibility could not be easily determined. Here again structural difference between legal and scientific institutions come into play. The Society could afford to take a somewhat looser view of evidence because it could engage in incremental correction of its findings of fact over time, something a court, bound by *res judicata*, could not do.

We should recall, too, that Boyle's *General Heads for the Natural History of a Country, Great or Small Drawn Out for the Use of Travellers and Navigators* as well as Hooke's and Rooke's instructions, relied on travelers and seamen whose social status and reliability were often unknown. The Society was thus dependent on accounts such as one on the Peak of Teneriff "received from some considerable Merchants and Men Worthy of Credit." Henry Stubbe attacked the Royal Society precisely because it made use of "Narratives picked up from negligent, or unaccurate Merchants and Seamen . . . men of no reading."[56]

Although the Royal Society might have preferred the testimony of members to nonmembers and gentlemen to sea captains, ordinary seamen, and traveling merchants, it had to rely on those with the opportunity to observe the desired natural phenomena. Hooke's statements concerning the need to filter and assess reports and Boyle's attempts to interview travelers personally suggest awareness of credibility problems involving both gentlemanly and nongentlemanly reporters.[57]

Reluctance to define the credibility issue in terms of social class is reflected in *The History of the Royal Society*, some portions of which emphasized the role of the gentleman, while others insisted that philosophy necessitated participation by the "vulgar." "Sound Senses and Truth" was "sufficient Qualification," there being enough variety in the Society's work to include those with "the most ordinary capacities." "Noble Rarities" were presented "not only by the hands of Learned and profess'd Philosophers; but from the Shops of Mechanicks; from the Voyages of Merchants; from the Ploughs of Husbandmen; from the Sports, the Fishponds, the Parks, the Gardens of Gentlemen." The Royal Society required "plain, diligent and laborious observers" who, though lacking scholarly knowledge, "yet bring their hands, and their eyes uncorrupted."[58]

Experience, Skill, and Expertise

Clearly, experience, skill, expertise, and opportunity to observe provided counterweights to gentle status. The Royal Society received its

"intelligence" from "the constant and unerring use of experienc'd Men of the most unaffected, and most unartificial kinds of life." Those who pursued the history of trades were dependent on craftsmen and tradesmen, who combined relatively low social status with craft knowledge and expertise. Hooke could thus stress both the importance of learning from workmen and the danger of being manipulated by them. Glanvill was not unusual in sending information on mining from "some very experienced Minemen."[59]

Skill and experience were important criteria. Oldenburg emphasized the "skill and faithfulness" of those who make "tryalls and take observations," and Hooke, skills in mathematics and mechanics, the ability to draw well, and willingness to work cooperatively. Without appropriate skills it would "be almost impossible to Anser many very essential quaeries with sufficient accurateness & certainty and consequently they will become very lame & useless." Those "not skilful in the History of Nature" were "apt to impose upon themselves and others."[60]

Robert Boyle provides the centerpiece for the arguments both of Shapin and Schaffer and of Rose-Mary Sargent, the former two emphasizing Boyle's commitment to the norm of gentlemanly credibility, the latter underscoring the role of experience and expertise in Restoration natural investigations.[61] The evidence with respect to Boyle is mixed. On one occasion Boyle thought an account credible precisely because it was not written by "a Philosopher to . . . serve an Hypothesis, but by a Merchant or Factor for his Superiors, to give them an account of matter of fact."[62] In another he obtained "credible relations" from both masons and a gentleman of his acquaintance.[63] He also accepted as credible a report from a "rich and judicious" merchant, adding, however, that he was "more addicted to letters than is usual to men of his calling."[64] On the other hand, he was troubled by the fact that so few tradesmen were versed in natural philosophy or could "give . . . a clear account of their own practices." In another mood, however, Boyle indicated that much could be learned from craftsmen and tradesmen, precisely because they were "were diligent about the particular things they handle."[65]

Boyle sometimes underlined the capabilities of ordinary persons. When observing "obvious phaenomenon of nature, and those things, which are almost in everybody's power to know, (if he pleases but seriously to heed them), . . . that attention alone might quickly furnish us with one half of the history of nature." Here ordinary but careful individuals were suitable scientific witnesses, little different from witnesses who provided testimony to the courts. Experimental work and more difficult observations, Boyle wrote, required a different kind of observer, it being very difficult "to make and relate an observation and faithfully enough for a naturalist to rely on."[66]

"Humane Testimony," for Boyle, was "of great and almost necessary use" in natural philosophy. Like the testimony of witnesses in the courtroom, that testimony might be "Insufficient for want of moral qualifications in him that gives them . . . [or] insufficient if the Matter of Fact require Skill in the Relator."[67] Boyle made it clear that "the better qualified a witness is, in the capacity of a witness, the stronger Assent his Testimony deserves . . . for the two grand requisites of a Witness [are] the knowledge he has of the things he delivers, and his faithfulness in truly delivering what he knows."[68] Here again the attributes that weigh most heavily are skill and the moral approbation of the reporter, neither of which was associated exclusively with gentlemen.

Shapin has contrasted the moral and epistemological competence of gentlemen with the doubtful cognitive competence of skillful technicians, underlining the epistemic differences between gentlemanly observations and those of mechanic laborers. Yet Hooke was not a gentleman, and much of the Royal Society's experimental program was dependent on his skill at experimental design. Without Hooke, who mixed easily with gentlemen, high-ranking government officials, clergymen, and even the king despite his lack of gentlemanly status, the Society's knowledge-making capacities would have been seriously impaired. Hooke's contributions to natural history and natural philosophy were widely known and respected. As Hooke himself put it, natural history was to be the work of "a society of men of the most accomplished abilities, of such as have an eminency both of Parts and Fortune, & of such as have a will as well as abilities."[69]

Fidelity

References to the fidelity and integrity of witnesses figure as prominently in the writings of naturalists as they do in historical and legal publications.[70] The expression "a faithful history" became a commonplace of natural history. When Henry More criticized Boyle's position on an experimental matter of fact, he nevertheless indicated that Boyle's testimony was so faithful that his reports of natural phenomena would themselves serve as "the judicature of nature herself." The *Philosophical Transactions* contained an attempt to calculate credibility mathematically, in which the credibility of the reporter was rated by both "his Ability" and his "Integrity or Fidelity."[71]

Given the prominence of religious polemic and the Protestant antipathy and distrust of Catholicism, it is noteworthy that religious affiliation was not important in assessing the fidelity of the scientific witness. The Royal Society had several Roman Catholic members, communicated regularly with continental Roman Catholic virtuosi, and at one point sought

information from "curious and philosophically given" Roman Catholic missionaries.[72]

Multiple Witnesses and Concurrent Testimony

The virtuosi adopted the legal preference for multiple witnesses. Although often enunciated, this preference could not always be satisfied, particularly where travelers' reports or testimony about singular events were involved.[73] Hooke insisted on recording the number and names of those who had observed experiments. Ideally, two or three persons should be present to observe and judge experiments before they were registered.[74] Boyle too emphasized that the number of concurring witnesses to a fact substantially increased its credibility, explicitly invoking the legal analogy. He notes that in murder and other criminal causes in England "it is thought reasonable to suppose, that, though each Testimony single be but probable, yet a concurrence of such Probabilities (which ought in Reason to be attributed to the Truth of what they jointly tend to prove) may well amount to a Moral certainty, such a certainty as may warrant the Judge [in a murder proceeding] to proceed to the sentence of death against the Indicted party."[75]

Boyle's position is remarkably similar to that of Judge Hale, who insisted "that which is reported by many Eye-witnesses hath greater motives of credibility than that which reported by few."[76] The replication of experiments first done in private before the assembled Royal Society is illustrative of the influence of legal procedures. Where later natural philosophy treated replicability as part of a peculiarly scientific method in which one individual investigator checked on another, the Society often treated replication as a mode of creating multiple witnesses whose testimony could be employed to prove a past event.

Judgment on Facts

Although portions of Sprat's *History* suggest that the Royal Society would, jury-like, make judgments on matters of fact, and other members such as Sir William Neile argued that those fittest to make the experiments were fittest to judge them,[77] this was not a responsibility that members readily assumed. There were no juries of naturalists who reached final judgments on the facts or, for that matter, naturalist judges who made authoritative findings of law.[78] While there are a good many statements from the virtuosi that suggest that some matters of fact might reach the status of moral certainty, there were no institutional arrangements for determining when they had done so. Allowing any individual or group to pronounce authoritative judgments about the principles of nature also violated the

virtuosi's antiauthoritarian principles. Legal systems require means of establishing authoritative statements of both facts and law. The natural philosophers did not.

Witness Fallibility and Human Weakness

Testimony concerning natural phenomena and experiment was thought to be impaired by human fallibility. If the senses were faulty, how could matters of fact based on observation and experiment reach the desired status of moral certainty, which engendered belief beyond reasonable doubt? From the time of Bacon onward it was suggested that such problems might be mitigated by the use of scientific instruments and the testing of sense by reason and reason by sense. Faulty memory was also recognized as a problem. The imperfections of memory led Hooke and others to insist on the immediate recording of observations.

The sense of fallibility was also related to the Christian sense of original sin and the vast differences between human knowledge and divine omniscience. The question of how far human weakness impaired human knowledge was a topic of considerable discussion during the Restoration as rational theologians and latitudinarian divines attempted to expand the uses of reason in religion without denying human fallibility. Both Restoration virtuosi and latitudinarian theologians emphasized the possibility of morally certain facts while denying one could know the ultimate principles that governed God's Creation.[79]

The testimony of witnesses, though crucial, was imperfect. It was weakened when witnesses were partial, unfaithful, or dishonest, defects that might result in "falsities in matter of Fact."[80] Matters of fact thus might be inadequately supported or even untrue. In short, in natural philosophy as in law, "matter of fact" had more connotation of issue and less connotation of settled knowledge than the word "fact" later acquired. Only those facts proved to a "moral certainty" could be confidently believed.

Conflicting Witnesses and Controversies about Matters of Fact

Although the virtuosi were disinclined to consider the epistemologically troublesome problem of conflicting testimony, they encountered it on those occasions when well-respected observers differed in their observations. In such cases the Royal Society faced the choice of reaching a "judgment" on the facts, much in the same way that a jury might, or of evading decision.[81]

Three kinds of problems surfaced. The first involved differing observations of the same phenomenon made by seemingly reliable witnesses. The second arose when the matter of fact did not seem possible or the reporter

credible. The third occurred when claims were made that the conclusions drawn from suitably recorded facts were as certain as the facts themselves.

If Royal Society spokesmen and members often analogized the role of the Society to that of the law court, in practice they avoided making collective judgments about matters of fact, even when judgment was sought by disputing parties. One of the most dramatic disagreements causing embarrassment for the Society concerned the 1664–65 comet observations of Adrien Auzout, a well-regarded French astronomer, and Hevelius, the respected author of *Selenographia* (1647), a Baconian "history of the moon."[82] Their dispute was referred to the Royal Society for adjudication, and the participants quickly adopted legalistic language. Because their differences concerned "matters of fact," Viscount Brouncker thought "authority, number and reputation of other Observers" should "cast the Ballence."[83] The testimony of other astronomers who had observed the comet supported Auzout, and the *Philosophical Transactions* noted that "unanimous consent" had been established. Echoing Brouncker, it reported that the "Controversie being about matter of fact, wherein Authority, Number, and Reputation must cast the Ballance, Mons. Hevelius, who is as well known for his ingenuity, as learning, will joyne and acquiesce that sentiment."[84] Hevelius, who continued to characterize fellow members of the Royal Society as "skilled and impartial judges," replied that he would "acquiesce in their judgment" but expressed hope that they "would not pass judgment . . . because of the plaintiff's importunity, . . . before I offer my just proofs and defense." What he "depicted with great care" was what he had seen "together with other notable persons."[85] He and Auzout thus both invoked multiple supporting witnesses.

Moray, continuing to employ legal language, suggested that the Society "give Hevelius his doom" but recommended that a few members, rather than the whole Society, respond. Oldenburg was to inform Hevelius of "his doom concerning his mistake" as well as the fact that the astronomical experts "consent against him." Feeling himself to have been "condemned without a hearing," Hevelius requested one "as truth and equity demand." He asked the Royal Society, which he characterized as "free from prejudice and self interest," to "rigorously investigate, examine, compare . . . [and] then declare their judgment." Oldenburg insisted that there had been no condemnation. But "since controversies of that kind" could be settled only "by weighing the number and qualities of the observations," he suggested Hevelius abandon his position.[86]

The matter, however, did not rest there. The possibility of two comets was explored as a way of evading the embarrassing problem. John Wallis wrote Oldenburg, "I see not why wee should disbelieve him in matter of fact," since Hevelius had used the best instruments and there was no reason to suspect that either astronomer "would willingly falsify an observa-

tion." He preferred "to suspend judgment" rather "than determine anything concerning it."[87] In seeking to resolve this conflict the participants referred to the consensus of skilled astronomical experts rather than the social status of the observers.

When a "controversy about matter of Fact or Experiment" developed between Fabri and Borelli, Wallis suggested further experiments as a solution.[88] Fortunately, major disputes over matters of fact seem to have occurred mostly among foreigners, who were unlikely to experience unpleasant face-to-face contact in London.

In other instances, the problem was the credibility of a report of an individual or group of individuals. Boyle recognized that the credibility of "wonderful" reports might be questionable.[89] The epistemological issue was not directly faced, and the most common response to difficult-to-believe testimony, like that of conflicting testimony, was silence rather than outright denial. Outright denial of incredible testimony provided by seemingly credible witnesses would have undermined the concept "fact" and the disciplines that were founded on it.

Although the Royal Society appropriated the legal language of credible witnesses and often employed other legalistic language, its members were unwilling to adopt either the adversarial role of lawyers or the role of juries as judge of facts. The virtuosi operated in a different institutional and cultural arena. Legal institutions exist to settle disputes authoritatively, not evade them, and to impose state power to enforce their decisions. The Royal Society was primarily investigative in character and discussion-like in discourse, not a decision-making body. It avoided making decisions between contending parties which would undermine collegial enterprise, raise the specter of authority, and perhaps threaten the whole basis of a fact-establishing natural and experimental history.

Scientific Instruments and Natural Facts

The new natural and experimental history relied on sense observation but recognized the weaknesses of the unassisted senses. These weaknesses were, it was believed, at least partially correctable. Baconians as well as non-Baconians such as Galileo and Descartes made good use of sense-enhancing scientific instruments.[90] The advent of the microscope and other instruments modified observational possibilities and thus the nature of witnessing. New and improved instruments permitted previously unknown or barely known phenomena to be observed and more accurately measured.[91] "By the help of telescopes there is nothing so far distant but may be represented to our view; and by the help of Microscopes, there is nothing so small, as to escape our inquiry; hence there is a new visible World discovered to the understanding. . . . the Earth itself . . . shews quite

a new thing to us, and in every little particle of its matter, we now behold almost as great a variety of Creatures, as we [are] able before to reckon up in the whole Universe itself."[92] The demand for multiple witnessing and replication increasingly referred to microscopic or telescopic observations. Anatomy, embryology, and pathology were transformed by the microscope,[93] and other instruments, such as Hooke's air pumps, enabled Boyle's experiments to go forward.

Because instruments enhanced perception, greater credibility was assigned to instrument-based testimony.[94] Those using telescopes were better witnesses than those without them, and those with the best telescopes became more reliable witnesses than those with simpler ones. Legal and historical witnessing remained dependent on the visual acuity of the average person. Here legal and scientific witnessing began to diverge. The virtuosi adopted legal concepts but modified them to suit different investigative conditions. In time, scientific instrumentation and the ability to construct repeatable experiments were to generate in observers of natural phenomena a sense of superior expertise.

The observation of natural occurrences, however, was treated somewhat differently than the reporting of experimentally produced facts. Sir Matthew Hale reminded readers that although the telescope enabled the senses to perceive stars or other objects impossible without it, the "Stars in the Milky-way" were not "in the Heavens . . . because the Telescope hath discovered them, for they were there before." Telescopic observation did "not make the thing to be, but evidence them to be."[95]

Experiment added a new dimension to witnessing, because it typically involved equipment, making it possible to manufacture "matters of fact." The virtuosi's involvement in experimental knowledge-making eroded the traditional distinctions between theory and practice and between art and nature. The possibility of replication differentiated the experimental witness from the legal or historical witness of past events and from the witness of one-time natural events.

Instrumentation and experiment distinguished the virtuoso from the ordinary observer, but they did not eliminate the need for "witnessing" itself. "Fact," for the seventeenth century, required a human presence. Without witnesses, "facts" could not be established and in some sense did not exist as "facts." Given an approach to natural philosophy that made natural history its foundation, it was essential that the "matters of fact" on which that philosophy was to be built be secured with as much certainty as humanly possible. Every effort had to be made to ensure the credibility of the scientific observer. The prior acceptance of witness testimony for legal and historical matters of fact helps explain the relative lack of concern among the virtuosi about the proper method of establishing the natural history foundation on which natural philosophy would eventually rest.

Problems: "Things" and Witnesses, Fact and Classification, Fact and Illustration, Circumstances

The introduction of the "fact" into the realm of natural philosophy brought a number of difficulties, some of which were recognized and others ignored. From an epistemological standpoint the largest problem was the faith placed in observation and experiment. If "facts" thus established were not secure, neither were the new natural and experimental histories on which the new philosophy was to be based. On the one hand, it was argued that facts might be established to a moral certainty or beyond reasonable doubt. On the other hand, it was recognized that not all matters of fact could be established with that level of certainty. The senses by which facts were established were capable of error. While error might be reduced by multiple witnessing and the use of sense-enhancing instruments, consciousness of human fallibility remained a fundamental assumption of early modern culture. Instruments, after all, might introduce distortion or result in differing interpretations of what had been seen. That there was so little thoroughgoing skepticism in England, however, meant that the awareness of human weakness did not run deeply enough to undermine a faith in a highly probable, if not certain, factual knowledge even when difficulties were acknowledged.

Experimental results, for instance, were "often various, and inconstant, not only in the hands of different, but even of the same Triers." The proper response to such difficulties was repetition and "jealous and exact Inquiry" to ensure that precisely the same ingredients be used in the same way "and the same circumstances be punctually observ'd." Then, Sprat maintained confidently, "the effect without all question will be the same." Sprat also recognized that the Royal Society's acceptance of accounts that might "seem expos'd to overmuch hazard, and uncertainty" was a problem. But the Society could reduce "such matters of hear-say and information, into real, and impartial Trials."[96]

If one of the most common uses of "fact" involved the observation and description of natural events and "things," there was occasional confusion between "fact" and "thing." Although "fact" required the observation of human witnesses to particular events and experiments, "objects," "things," or "specimens" sometimes became so closely associated with "matters of fact" that they were occasionally referred to as "silent witnesses" or testimonies capable of producing "fact." The traditional distinction between "things" and "words," or *res* and *verba*, also confused matters. "Facts" were neither *res* nor *verba*.

Nature itself, then, might in some sense provide "testimony." Boyle was said to appeal "to the Testimony of Nature, to verify his Doctrine." Yet for Boyle, "things" and inanimate bodies, which had the advantage of being

without bias, did not literally speak for themselves.[97] Those who dug up fossils or other objects occasionally did call such things "Witnesses for themselves."[98] For antiquarians, Roman remains were similarly objects that "do abundantly witness."[99] For Hooke, shells and other natural objects were "the Medals, Urnes, or Monuments of Nature whose Relievoes, Impressions, . . . are much more plain and discoverable to any unbiassed Person, and therefore he has no reason to scruple his assent. . . . These are the greatest and most lasting Monuments of Antiquity, which in, all probability antidate the very pyramids, Obeliks, . . . and Coins, and will afford more information in Natural History, than those other put altogether will in Civil."[100] The Royal Society members prided themselves on dealing with *res* or "things" rather than *verba*, but they did not clarify the relationship between *res* and "fact." Moreover, since verbal narratives or description by observers remained the standard mode of establishing matters of fact, the contrast drawn between *res* and *verba* was not as clear as it sometimes appeared to be.

Nor was it always clear whether experiments themselves yielded "testimony" or whether human beings were necessary to "witness" and report the observed experimental events. At one point Boyle suggested that the pressure of water in his experiments had "manifest effects" on "inanimate bodies" and that these experiments did not suffer the weaknesses of human witnesses, being incapable of "prepossessions, or giving us partial informations."[101] There appears to have been a silent process at work in which the "scientific fact" based on witnessing was being elided so that the "thing" or experiment itself took on the functions of human reporting of fact.

Problems relating to "fact" were also created by new classification systems, such as that of John Wilkins, which aspired to include all categories of things and concepts. Could such prearranged and preconceived systems be satisfactorily linked to the observed "facts" of natural history? What was to be done when observed matters of facts did not fit the categories? We find John Ray complaining that Wilkins's system, on which Ray himself had worked, did not, in all respects, conform to his observations of plants.[102] Here "fact" and "classification" are at odds. On the other hand, Martin Lister emphasized that thanks to his "extremely minute but extremely faithful observations" of spiders, his classifications were "not arbitrarily or artificially imposed on the facts, but inspired by the particular features of the animals themselves."[103] The arrangement of particular "facts" into categories and classifications was important to some but not all naturalists. The relation of the particular to the general was, of course, a problem felt beyond the boundaries of classification systems.

Similar vaguely perceived and unresolved problems were encountered about scientific illustrations, representations that were neither the

"things" themselves nor verbal testimony about them. Their status was complicated by the fact that they were often prepared by persons other than eyewitnesses. There was talk of the value of illustrations but little examination of their epistemological status.[104]

Naturalists often wrote of the need to record the "circumstances" surrounding the primary facts they described. Shapin has called this practice "virtual witnessing," since it was designed to reproduce in the reader the experience of the eyewitness.[105] Virtuosi such as Boyle and Hooke used the term "circumstances" in connection with "matters of fact," but they, no more than the lawyers and judges who employed the term, really defined its meaning.[106] The epistemological status of the "circumstances" surrounding matters of fact was left unexamined, and it is not clear whether they were to be included to increase "verity" or "verisimilitude." The addition of "fact" to the realm of natural philosophy both modified and confused the epistemological terrain.

Judging and Judgment

The words "judging" and "judgment" had many uses and a variety of related meanings. Judging was, of course, central to courts. Juries exercised their rational faculties on the materials provided by sense and testimony and attempted to reach sound judgments on the matters of fact before them. "Judgment" was also used to characterize many activities outside the courtroom, often, however, retaining a somewhat legal cast. Historians, as we have seen, either reached "judgments" themselves or turned over that function to readers who considered the evidence presented to them. Moral judgment, which was at the heart of casuistry and moral philosophy, was well known. Casuists frequently analogized moral judgment to that of the courts. "Judgment" combined, conflated, and/or confused empirical, logical, and normative conclusions.

Natural philosophy was also enmeshed in the language of judgment. Judgments might be reached with respect to matters of fact or, as we see shortly, hypotheses and theories. If the Royal Society evaded institutional "judgments," individuals often made assessments of the testimony they heard. Sprat wrote of the Royal Society, "There will be always many sincere witnesses standing by, whom self-love will not persuade to report falsely, nor heat of invention carry to swallow a deceit too soon; as having themselves no hand in the making of the Experiment, but onely in the Inspection. So cautious ought men to be, in pronouncing even upon Matters of Fact."[107] Such judgments were not to be placed in the hands of a single person or a company of like-minded individuals but to be made by the Royal Society's "men of various studies."[108]

Good judgments about matters of fact, whether in natural philosophy

or elsewhere, required evidence from experienced, skillful, impartial, disinterested observers of good moral character with appropriate opportunity to observe. Multiple witnessing and access to sense-enhancing instruments and experimental equipment too entered into "judgments" about the truth of matters of fact.[109]

The Norm of Impartiality

The norm of the impartial investigator, so fundamental to modern scientific ideology, became an integral feature of Restoration empirical philosophy when it adopted the concept "fact." The norm of impartiality was particularly indebted to the legal tradition, where the very notion of "justice" implied impartiality, lack of bias, and avoidance of partisanship. Judges, juries, and witnesses who prejudged or were "prejudiced" were thought to undermine or contaminate the legal process. Both the common and civil law provided institutional safeguards to prevent interested witnesses and thus biased judgments. The common law prohibited various kinds of interested witnesses, provided for jury challenges, and imposed property qualifications on jurors to help ensure impartial outcomes. Historians, too, donned the mantle of impartiality, claiming to make unbiased judgments or requesting that the impartial reader do so. The "news" media and travelers also promised "true and impartial relations." The norm was common to all the discourses of fact.

The norm of impartiality quickly became part of the fact-oriented empiricism of the Royal Society. Members frequently reiterated their emphasis on lack of interest and bias.[110] Boyle saw himself as cultivating "chemistry with a disinterested mind; neither seeking nor scarce caring for" any "personal advantages" from it. He also emphasized the impartiality of experimental data. In discussing the Hevelius controversy, Wallis stressed the need for "disinterested, and unbiased persons to judge." And impartiality and lack of prejudice were sometimes imputed to the reader in natural as well as historical reporting.[111] The writings of the English virtuosi are suffused with statements about the need for impartiality as well as with the difficulties of attaining it.

Virtuosi were far less likely than were historians and newsmen to accuse fellow investigators of partiality and prejudice. Faulty reports or judgments were more apt to be ascribed to observational error, lack of experience, or the absence of suitable instruments or apparatus. Adoption of the Baconian cooperative vision, relative freedom from the "idols" generated by conscious and unconscious partisanship, and rejection of the adversarial model of courts may well have reinforced the disinclination of the virtuosi to denigrate the judgments of others.

The Witnessing of Nature and the English Culture of Fact

The role of witnessing in natural matters of fact was part and parcel of a larger system of knowledge, which initially dealt with human and, in some instances, divine testimony. That system, at least the outlines of which were of medieval origin, developed rapidly in England during the second half of the seventeenth century, culminating in Locke's *Essay on Human Understanding* (1690).[112] Most English thinkers concerned with issues of probability and certainty emphasized "matters of fact." Precisely because the new scientific community sought proofs beyond a reasonable doubt, it sought to build a new natural philosophy on the basis of a sound natural history. The witnessing of natural and experimental matters of fact could provide a basis of proof beyond reasonable doubt. This approach was promising because the category "matter of fact" and the method of establishing facts to a moral certainty that is beyond reasonable doubt were already well-established parts of English experience. The desired attributes of testimony first worked out in detail by lay and clerical lawyers became integral components of a common European culture. Ultimately, these ideas were most developed in England, in part because they had become a constituent element of English empirical natural philosophy. The widely known Lockean generalization of this approach would make "fact" an even more important feature of the English intellectual landscape.

Geographical Diffusion: The Case of France

Given our focus on English culture, we have had little to say about comparable developments elsewhere. Although the expansion of the concept "fact" from human to natural events and phenomena occurred first in England, the "natural" or "scientific" fact did not remain an English preserve. If Baconian-style natural and experimental histories came to play a role in France, more traditional styles of natural philosophy, with their emphasis on general experience rather than particularities, had a more prominent place and a somewhat longer life there.[113] More influential in France than England, Cartesian natural philosophy did not accord the "facts" of observation and experiment as central a place as they had in the English empirical tradition. Although Descartes himself was involved with observation and experiment, they remained subordinate to a science of causes. Neither the Aristotelians nor the Cartesians appear to have used "fait." Nor does Gassendi's more observationally and experimentally grounded probabilistic natural philosophy appear to have made use of "fait" or "factum" in connection with natural phenomena. Those writing in Latin, as we noted early, were less likely to use "factum" for natural phe-

nomena. The connection between the language of "fact" and a probabilistic empiricism such as Gassendi's was not a necessary one. The practice of natural history took hold in France as elsewhere, and experiment was integrated into both traditional and Cartesian natural philosophies. The circles around Peiresc and Mersenne included natural historians and experimentalists but do not seem to have used "fact" or "fait" in connection with their activities. Although "fait" was widely used in French law and historiography, it does not appear to have been used in connection with natural phenomena or experimentation during the first half of the seventeenth century.[111]

The term "fait" appears to have been adopted in France by natural historians associated with the Académie de Sciences in the 1660s. Like the English, they distinguished between descriptive natural history (*l'histoire*) and natural philosophy (*physique*) as well as between history and explanation. A Baconian style of natural history was an early item on the agenda of the Royal Academy of Sciences. It seems likely that the "natural fact" was introduced in France in connection with the Academy's natural history program.[115]

Claude Perrault's *Memoirs for a Natural History of Animals . . . dissected by the Royal Academy* employs "fact" (*fait*) in applying a distinction already common in civil history to natural history. All history, Perrault commented, is written in one of two ways: "General history" relates "all the things which have at several times been collected, and which do belong to the Subject it Treats of." Alternatively, "we are confined to the Narrative of some particular Acts, of which the Writer has a certain knowledge." The latter form, labeled commentaries by the Romans and memoirs by the French, contained only the "Elements" of history and lacked "the Majesty found in that which is general." If the historian was "exact and sincere," however, memoirs had the "Advantage" of "certainty and Truth." "General Histories of Animals" were characterized by inexact and unfaithful "Descriptions" laid on "sandy Foundations."

The natural historical "memoirs" provide "unblemishable evidence of a certain and acknowledged Verity." These were "not the work of single person, . . . overly fond of his work and who less considers the truth of the Facts [*la vérité des faits*], which are not his own Production." They contained "only Matters of Fact verified by a whole Society" (*que ne contiennent point de faits que n'aient est vérifiez par toute une compagnie*), composed of men well qualified "to see these sorts of things . . .; who study not so much to find out Novelties, as carefully to examine those pretended to be found; and to whom even the Assurance of being deceived in any Observation, being no less satisfaction than a curious and important discovery; So much the Love of Certainty prevails in their spirit above all other things."[116] The Academy, unlike the Royal Society, did not seek to enlist merchants, trav-

elers, and sea captains, who in its view were insufficiently "indowed with [the] Spirit . . . [of] Philosophy and Patience" to provide the necessary sound foundation for natural philosophy.[117]

Like the members of the Royal Society, the academicians sometimes went beyond reported matters of fact but would not pretend "to put a value on our Conjectures, farther than particular Facts [*faits singulars*] can prove them." "Facts" had priority because philosophy "ought to be grounded on the knowledge of all particular things [*toutes les choses particulières*]." Thus instead of saying bears have fifty-two kidneys on each side, they would say only that the particular bear they had dissected had such a conformation.[118]

The academicians would not place "over much reliance on the Reason, which we have intermixt amongst our Experiments, and that it will easily be judged, that we pretend only to answer some matters of Fact which we advance." "Facts [*faits*] are the sole Powers" to prevail against traditional authority. Yet the academicians, like members of the Royal Society, would not limit themselves to memoirs, since it was "impossible to Philosophize without making some general Propositions." These must be "grounded on the knowledge of all particular things [*Ces faits sont le seules forces . . .*]." Carefully verified matters of fact would provide the foundation of their natural history.[119]

A number of French naturalists were in frequent contact with their English counterparts. Huygens, who lived in France, corresponded regularly with Sir Robert Moray, as did Auzout, Justel, and Duhamel with Oldenburg. Oldenburg suggested the possibility of a philosophical alliance between England and France, and Sprat, who thought France "next to England" in its zeal for the promotion of experiments, emphasized the Royal Society's "perpetual intercourse" with French philosophers and the value of reports from "their most Judicious Travellers."[120]

Fontenelle's 1699 *Memoirs of the Royal Academy of Science* echoed Perrault in emphasizing the particularity of "facts" and the distinction between fact and conjecture. The Royal Academy would produce collections "composed of separate Fragments, independent of one another: whereof every one who is the Author, warrants the Facts and the Experiments."[121]

Our sketchy evidence for France suggests that the concept "fact" migrated from law and history to natural history and that particular observations and experiments played a significant role in that migration. Although Lorraine Daston has suggested that the French use of "fait" was less firm than the English "matter of fact," "fact" or "fait" had become part of the vocabulary of French naturalists.[122] Daston's contrast may be somewhat overdrawn, because English use of "fact" also referred to both morally certain facts *and* "matters of fact" insufficiently supported by credible witnesses.

We know even less of the history of "fact" in other European locales. It was Iberian encounters with unknown parts of the world that led observers to depart from the authority of traditional natural history texts. Garcia d'Orta, the first European to provide accurate descriptions of Indian plants and medicines, Bartolomé de las Casas, Gonsálo Fernández de Oviedo, and Francisco Hernández emphasized the value of eyewitness testimony. Although such ventures produced greater descriptive accuracy, more accurate mapmaking, and the importation of exotic flora and fauna from Brazil, Africa, and India, we do not yet know how and when "fact" (*hecho*), already part of the Spanish legal terminology, entered the Iberian natural history vocabulary.[123]

The Spanish Crown certainly encouraged acquisition of what we today would call factual information. The Council of the Indies created the office of cosmographer-chronicler and produced printed questionnaires for distribution in Spain's American possessions in order to compile useful topographical, navigational, and natural history data. This effort, larger in scale than that of the Royal Society a century later, was of much the same character. While the Royal Society was self-consciously engaged in gathering well-supported "facts," we do not yet know whether the Spanish effort was characterized as "fact" collection. One might speculate that the transition from human acts and deeds to natural phenomena took place rather late in Spain because of the decline of Spanish natural philosophy at the end of the sixteenth century and Spain's lengthy adherence to Aristotelian science.

In the Netherlands, as elsewhere, "matter of fact" in law (*het feit*) was the companion of "matter of law" and was used in a number of law-related contexts. For most of the seventeenth century, it appears that "feit" was used only in connection with human occurrences and events.[124] There were, of course, significant Dutch contributions to detailed natural history, microscopic observation and experiment, exact description of physical objects and locales, and medicine, cosmography, and the collection and cataloging of specimens from the far-flung parts of the globe. All these were areas where "fact" was deployed by the English. One would expect that the Netherlands would have provided fertile ground for development and/or acceptance of the concept of fact in relation to natural phenomena.[125]

All European countries adopted the legal distinction between question or matter of fact and question or matter of law and employed "fact" in the context of historical work. If the English were the first to make "fact" central to natural history and natural philosophy, there remains much to learn about how and when that process was extended to other national cultures.

Conclusion

At the beginning of the seventeenth century what today we would call the "scientific fact" did not exist. With the Restoration, well-supported "matters of fact," whether alone or in the company of "hypothesis," played a major role in the research program of the Royal Society and in the English natural history and natural philosophy community more generally. This chapter has attempted to show how a concept initially employed to deal with human actions and deeds was self-consciously adopted by empirically oriented naturalists. Bacon, we have suggested, played a pioneering role in transforming the "human fact" into the "natural fact" by applying the legal witnessing criteria to particular natural events and experiments. His role was supplemented by an English descriptive chorographic tradition in which human and natural "things" and "phenomena" were observed and recorded by the same procedures and mental processes as those employed by historians of human events.

We have also seen that the language and practice of the Royal Society, like all the "discourses of fact," exhibited features derived from the legal arena—emphasis on witnesses, preference for multiple witnesses, the rejection of hearsay, criteria for evaluating witnesses, and a concern for the degree of certainty to be attributed to witnessed matters of fact. In law, "moral certainty" or "belief beyond reasonable doubt" was the highest possible certainty. The natural realm could claim a unique capacity for achieving such certainty because some of its observed facts and many of its experimentally created ones could be replicated before multiple, impartial, skilled, and often instrument-employing witnesses whose testimony could be presented in a nonadversarial setting.

This chapter has continued to trace a group of related characteristics and values that link the varieties of fact finding in a number of seventeenth-century disciplines. The most characteristic feature of the discourses of fact was witnessing, preferably eye-witnessing. Ideally, witnesses were of medium or high social status, independent, and of good moral character, all qualities that enhanced the credibility of their testimony. Although matters of fact involved both the senses and memory, the former was given greater attention. The "ocular" was favored over all others. Another important concern that natural philosophy took over from the legal sphere and the other discourses of fact was impartiality. We have come to see that the conception of the ideal investigator of natural phenomena overlapped with the ideal juror, judge, historian, travel reporter, and newsman.

Although legal concepts did not shape all aspects of English natural philosophy or absolutely determine any of them, the role of the legal tradi-

tion in the creation of the "scientific fact" is central. Yet law must be seen as primus inter pares among a number of parallel intellectual developments that collectively composed a culture of fact. We have noted, for example, how "strange but true" natural phenomena became "news" and how closely the conventions of news reporting paralleled the reporting norms of the naturalists, no matter how much less careful in practice journalists were in assessing the "facts" they reported. Our discussion of chorography, voyage reporting, and "moral history" also reveals striking similarities between their descriptive traditions and the discourse of natural history.

We have similarly traced a group of related values connecting the varieties of fact finding we have considered thus far. The most important were the linked values of impartiality and lack of prejudice, values first enunciated by the legal profession and then adopted by historians, travel reporters, and journalists as well as by observers of natural and experimental phenomena. The ideal scientific witness resembled the ideal legal witness, although the former's testimony might be enhanced by the employment of sense-enhancing instruments and experiment.

There are a number of things that remain somewhat elusive about the development of the scientific or natural fact. "Matter of fact" initially referred to a category of things that had to be adequately evidenced and witnessed to be believed. Appropriate testimony was required to substantiate satisfactorily the matter of fact if belief was to reach the level of "moral certainty." Many matters of fact failed the test, making some matters of fact more believable than others and some not believable at all. We thus encountered statements mentioning the possibility of error or mistake in "matters of fact."[126] Boyle, in discussing a "Design for a natural history," even suggested that an appendix where errors of fact could be recorded should be part of the design.[127] Some matters of fact thus were unsuitable to be believed by rational persons, although the notion of untrue, nonbelievable, improbable, or even false facts is alien to modern usage.[128] If we recall the legal origin of the concept "fact," we are less surprised at the notion of false, erroneous, or insufficiently substantiated matters of fact. In the adversarial legal context, "matters of fact" are really "issues of fact" to be pled and proved by one side against contrary pleadings and proofs by the other. One side or the other's matters of fact must be false or insufficiently proved. The process by which matter of fact became the modern "fact," with its association with "truth," is itself part of a historical process in which legal discourse is transposed into other disciplines and, in the process, transmuted.

CHAPTER SIX

The Facts of Nature II

The Gentlemanly Thesis

The "gentlemanly thesis" was first explored by Steven Shapin and Simon Schaffer in their pathbreaking *Leviathan and the Air Pump* and later extended and elaborated by Shapin in *The Social History of Truth*.[1] These books have focused attention on the shaping of knowledge and knowledge claims by social values and social hierarchies. In the first study the authors were especially struck by Boyle's emphasis on the social status of those who witnessed experiments. They contrast Boyle's experimental method and his reliance on "matter of fact" with the method of Thomas Hobbes, who found his model in geometry and emphasized a deductive mode that gave relatively little attention to experiment and observation of particulars. Shapin and Schaffer also suggest that Restoration methods of constructing "matters of fact" reproduced existing societal hierarchies.

More recently, Shapin has argued that the aristocratic and gentlemanly norms derived from Italian Renaissance aristocratic courtesy manuals were transferred to the ideal scientific investigator. He calls particular attention to the role of trust in scientific endeavor and argues that the societal convention of trust in a gentleman's word was adopted by the Royal Society. Shapin also suggests that English emphasis on social hierarchy led to the treatment of technicians, who lacked gentlemanly status, as ser-

vants. The contrast between Robert Hooke, the employed technician, and Robert Boyle, the high-status experimenter, is sharply drawn. It is Boyle, the embodiment of the gentleman-aristocrat, whom Shapin sees as giving shape to the scientific norms of the Restoration era.[2]

We have seen that the reliability of witnesses was a crucial issue in all the discourses of fact, including law, history, and natural history. In all of them social status was one but not the sole criterion of reliability. Expertise, experience, opportunity, number, disinterest, and impartiality were other criteria. When scientific witnessing is placed in the context of the common culture of witnessing of the time, gentlemanly trust recedes to one of a number of bases for trust.

It is doubtful that the clergymen, government officials, and physicians who were members of the Royal Society would have been considered gentlemen by Shapin's exemplar, Robert Boyle, or by Restoration social norms generally.[3] In fact, the social status of those in what we now call the professions was ambiguous. When a clergyman became a bishop and a barrister a judge, their gentle status might be confirmed, but only in the eyes of some. Sir Matthew Hale, a leading judge, renowned legal scholar, and sometime naturalist, was the son of a clothier and raised in a modest yeoman family. The prominence of the professions in fact-finding endeavors and the decisive role of middling-rank jurors in legal fact finding suggest that attention to "middling" social status ought not be too rapidly jettisoned.

As we noted earlier, the Royal Society aggressively sought reports of "matter of fact" from seamen and travelers. Had Boyle been wedded to the notion that only gentleman were worthy of credit, his efforts to cultivate such reporting would have made little sense. Robert Hooke certainly did not possess the social status of Boyle, but his observations, experimental findings, microscopic studies, and observations of comets, all of which were to be found under the rubric "matter of fact," were highly respected by fellow virtuosi.[4] Sprat did report that most Royal Society members were gentlemen "free and unconfined." He also noted the king himself brought tradesman John Graunt to the Society's attention and wrote "that if they found any more such Tradesmen, they should be sure to admit them all." Sprat urged the Society to have "careful regard" for "all sorts of Mechanick Artists."[5]

The contrast between the social status and ethos of scholars and gentlemen also is drawn too sharply by Shapin and Schaffer. To be sure, there was a substantial difference between the traditional scholastic disputation and the model of discourse adopted by the Royal Society, but a good many of the most prominent Royal Society figures—Wilkins, Ward, Petty, Bathurst, Barrow, Goddard, Wren, Willis, and Newton, among others—were, or had been, academics, and the Society's behavioral norms

had been worked out at Wadham College, Oxford, and in the earlier 1645 group at Gresham College.[6] There were a good many English institutions in addition to the universities where those of high and middling status mingled. Government offices, trading companies, religious institutions, the law courts, and the Royal Society itself provide examples.

In short, the culture of fact was as much a culture of professional success as of gentle courtesy. And the realm of professional success is one of competence and expertise. In natural philosophy as in law, social status bore on credibility, but so did expertise and competence. That expertise about nature was largely generated, as it was in most areas of human endeavor, by the opportunity for observation or learning by experience. In natural philosophy, experiments and instruments, and the increased observational specialization that came with them, redefined expertise. Such an invigorated expertise tended to undercut claims of social status. Ray may not have been quite a gentleman because of his dependent status, but his reports on plants were far more credible than those of an untutored squire.

As sense-enhancing instruments such as microscopes and measuring devices became more accurate and sophisticated, social status would matter less. The Auzout-Hevelius controversy presented grave difficulties to the scientific community not because of issues of social status but because astronomical instruments had so enhanced observational potential. The microscopic observations of Leeuwenhoek were doubted less because of his low social status than his reluctance to share his instruments.

We have seen the role of social status in assessing the credibility of witnesses in common law courts where social status was only one among a complex of *indicia* of credibility. Anyone who had seen and heard was a better witness than anyone who had not. Hearsay from a high-status source remained hearsay, and the credibility criteria developed in the context of canon and civil law predated the Renaissance courtier tradition. The fact that yeomen staffed most juries and determined "matters of fact" at common law suggests that the epistemologically significant line of social demarcation was lower than that of gentleman though perhaps higher than the "vulgar." Shapin and Schaffer are certainly correct in insisting that "matter of fact" was a social as well as an epistemological category, but that social category was being transferred from one kind of institutional setting to another—from the courts to scientific inquiry—and modified to meet the needs of the naturalists. It was the language of the law and the analogy to legal processes and criteria of truth, not the language of the courtesy manuals, that was constantly in the mouths of the virtuosi. And though the law took account of social status sometimes and for some purposes, it was most certainly not a realm of gentle courtesy.

Common law courts, however, employed an adversarial procedure en-

gaged in by highly self-interested parties. When "matters of fact" are transposed to a self-recruited scientific community composed of persons with common interests, it is not that a special climate of trust must be established by reference to gentle courtesy but rather that the special climate of mistrust and antagonism found in litigation is sloughed off. Shapin notes that Boyle insisted that experiments had to be actually witnessed by an appropriate number of suitable persons in a suitable physical space. That most of the witnesses might be gentlemen may have been comforting, but more important was a social setting in which, quite unlike the law courts, the experimenters and the witnesses were engaged in a mutual endeavor in which no participant had a strong material interest in falsifying facts. The problem the naturalists faced was error, not falsification.

In emphasizing Boyle's literary technique of "virtual witnessing," Shapin provides another form of the gentlemanly thesis. The reader will put his trust in Boyle's account because Boyle is a gentleman.[7] But juries, no more than readers of Boyle's texts, could literally see the events narrated. They too received witness testimony and reports of "circumstances." They thus engaged in a kind of "virtual witnessing," as did the readers of newsbooks, which Nigel Smith has suggested sought to create the illusion that the reader himself was witnessing the action.[8] Something akin to Boyle's "virtual witnessing" was shared by several, if not all, early modern "discourses of fact."[9]

As treated by Shapin and Schaffer, "matter of fact" is associated particularly with Boyle, and his predecessors and contemporaries are largely ignored. Without the Baconian insistence on natural and experimental histories based on firsthand experience, however, "facts" would not have become central to the Restoration scientific community. The crucial change that made possible the "scientific fact" was the application of the modes of proof of fact finding about particular human actions to particular natural and experimentally produced phenomena. In this application the gentle status of the investigator was a plus but was not decisive. And, of course, this adoption was characteristic not only of Boyle but of his many naturalist contemporaries in the Royal Society.[10] Even if Boyle was seen at the time as the embodiment of gentlemanly courtesy, there is little evidence that his predecessors and contemporaries were obsessed with gentility. Being in the class of gentleman obviously counted for a great deal in Restoration England, but it does not provide a sufficient guide to the creation and construction of the "scientific fact."

If the aristocratic and gentlemanly cultural ideal made prominent the attributes of honor, politeness, trustworthiness, and civility, we must also note the less desirable traits associated with that culture. Pride, arrogance, self-regard, and what Hobbes called "vainglory" were as much a part of aristocratic, gentlemanly culture as honor, politeness, and civility. If the

Renaissance court fostered civility, it was also the scene of fierce interpersonal competition and the "rhetoric of social combat." The courtly model was more competitive than cooperative, and the success of one aristocrat or gentleman was, more often than not, at the expense of another.[11] All this was a far cry from the deliberately low-keyed collaborative endeavors of the Royal Society.

Although Restoration society was preoccupied with social hierarchy and social status, England was less preoccupied than France, Spain, or Italy. One would therefore expect to find a greater role for socially based epistemological categories in those locales. Yet these countries were not in the forefront in constructing an intellectual category of natural "matter of fact" conforming to the socially dominant classes. Nor do we find that the more bourgeois Netherlands adopted a different set of socially influenced epistemological distinctions.

The relationship between those who exercise epistemological power and those who exercise political and social power in a socially stratified hierarchical society is a complex one that confronts students of medieval scholasticism and Renaissance humanism as much as it does those of Restoration natural philosophy.[12] The issues of knowledge and power discussed by Shapin and Schaffer are immensely important, but an extension of the narrow context in which they consider those issues suggests that a number of other social and intellectual forces were as important, if not more so, as the tradition of gentlemanly courtesy in establishing a culture of fact.

"Fact" and "Hypothesis"

Having explored the origins and development of the "scientific fact," we now turn to the question of what Restoration virtuosi thought was to be done with the appropriately verified "matters of fact" that constituted the natural history research program. Natural history, after all, was not natural philosophy. How might one move from "facts" to the explanations of those facts and to the discovery of the principles of natural philosophy?

If there was a consensus on how to establish facts, there was less agreement on how to develop natural philosophy.[13] Since relatively few members of the English scientific community in the pre-Newtonian era expressed confidence that their explanations and axioms could ever be as certain as the facts on which they rested, what was the relation between fact and explanation or generalization? Most Restoration virtuosi might have agreed that "rude heaps of unpolish'd and unshap'd materials" would not automatically yield philosophical principles. Most, however, did not adopt the method outlined in Bacon's *New Organon*. Even Sprat ad-

mitted that Bacon had been too inclined "to take all that comes, rather, then to choose; and to heap, rather, then to register."[14] Few were attracted to the forms of experimentalism adopted by the Jesuit scientific community or to Hobbes, whose natural philosophy provided little role for facts. Relatively few were committed to Cartesian natural philosophy.

The majority of the members of the Royal Society and the English naturalist community more generally, though often castigating overly speculative hypothesizing, were led to conjecture, hypothesis, and theory as a means of linking well-proved facts to some kind of generalization. The English scientific community was somewhat ambivalent about the employment of hypotheses, and few were ready to consider such conjectures, hypotheses, or theories as capable of the same degree of certainty as matters of fact. One might be "unquestionably sure" of the existence of many things but on uncertain ground in explaining "the nature of them." No man "in his wits could doubt" well-established facts, yet, once found, many "remained inexplicable."[15]

Some were content simply to accumulate facts, believing that explanations and principles could be put off, at least for the time being. Others, like Newton, felt that true principles or theory could be "deduced" from the facts. The most common, but never the sole, approach of the Restoration era was to link "fact" to "hypothesis."

"Hypothesis" had a long history in natural philosophy, mathematics, and mathematical astronomy before the introduction of the new natural history with its concept "fact." It had acquired a considerable range of meanings by the Restoration era. Naturalists were familiar with rival Copernican and Tychonic hypotheses. Hypothesis also played a considerable role in Cartesian physics, typically being offered as plausible or possible explanations that might be false.[16] Bacon discussed but was not sympathetic to hypothesis.[17]

The language of "theory," "hypothesis," and "conjecture" was rather unstable.[18] "Theory," like hypothesis, had mathematical associations and was sometimes used interchangeably with hypothesis, though for many virtuosi "theory" implied greater certainty than hypothesis. Many natural philosophers who referred to or employed hypotheses insisted that well-established matters of fact provided the appropriate evidence for the hypothesis in question. The same might be true for "theory," though this term was most often adopted when natural phenomena were described mathematically. "Conjecture" too was employed, most frequently in the context of "conjecturing on the causes" of some phenomenon or set of facts. In natural philosophy conjecture might be used as a synonym for hypothesis, especially by those unwilling to make strong statements in behalf of their explanatory claims, but, unlike "theory," it was sometimes associated with guessing.

Despite the variations in terminology, the joining of "fact" to "hypothesis" was a crucial development in Restoration natural philosophy. If some naturalists associated hypotheses with "fiction," "romance," and "mere speculation," the more prevalent view was that particular hypotheses attained higher or lower degrees of probability depending on how well supported they were by well-established matters of fact. There was disagreement over whether all hypotheses should be treated as equally probable, whether some hypotheses might be so certain as to be treated as laws of nature, the relationship between hypotheses and experiment, the role of reason in the construction and evaluation of hypotheses, and the importance of hypothesis formulation and testing for the construction of principles of natural philosophy. A clear distinction between the "hypothesis" as a tentative, causal statement derived from empirical observation and disconfirmable by further empirical observation and the more traditional usage of "hypothetical" as merely asserted and unconfirmed had not yet fully emerged. In the process of groping toward that distinction, the writings of the virtuosi often seem simultaneously to condemn and commend "hypotheses."

We explore the treatment of some of these issues by examining the views of Sprat and Glanvill, spokesmen and apologists for the new philosophy, and by sampling the views of several virtuosi, in particular those of Robert Hooke, Robert Boyle, and John Wallis, all of whom treated hypothesis rather extensively, if not always consistently. We conclude with Isaac Newton, who, whatever his actual practice, seemed to offer a radically different position on hypothesis.

Apologists and Spokesmen

We begin with Sprat's *History of the Royal Society*. Given that he was a hired publicist, selected by and writing largely under the supervision of John Wilkins, Sprat may be viewed as Wilkins's mouthpiece and thus as having an adequate understanding of Royal Society practice.[19] The *History*'s sometimes ambiguous and even inconsistent statements about hypothesis may be explained either as an attempt to comprehend a number of contradictory views or as expressing the Society's own ambivalence and uncertainty concerning "hypothesis."

Sprat often referred to hypothesis and conjecture rather suspiciously, but he also treated them positively when they were based on "matters of fact." Though the Royal Society refused to concern itself with general principles, these being "a kind of metaphysics," it was willing to conjecture on the causes of natural facts. But it insisted on circumspection, modesty, and wariness in order to avoid the "disguised Lies" and the "deceitful fancies" of "catching at" explanations "too soon." Continued experiments

would prevent "overhasty and precipitant concluding upon causes." Sprat provided numerous examples of hypotheses presented and discussed at Society meetings which dealt with astronomy, pendulums, fire, the air, filtration, earthquakes, petrification, the lodestone, tempering steel, light, colors, and fluidity. Some readers might "imagine that" hypothesis "consists not so well with their Method," which was "chiefly bent upon the Operative, rather than the Theoretical Philosophy," but Sprat emphasized that "by affirming, that whatever Principles, and Speculations they now raise from things, they do not rely upon them as the absolute end, but only use them as a means of farther knowledge." Hypotheses and "Doctrines of causes" served "to promote our Experimenting; but they would rather obscure, than illumine the mind, if" made "the perpetual Objects of our Contemplation."[20]

Sprat sometimes used "theory" interchangeably with "hypothesis." In writing of Wren, Sprat spoke of "theory"; Wren himself used "hypothesis."[21] Sprat treated "theory" positively in speaking of Wren, critically when he wrote of Descartes. He condemned those who disputed about the "Nature and Causes of Motion in general" without "prosecute[ing] it through all particular Bodies" and expressed reservations about virtuosi "a little too forward to conclude upon Axioms, from what they have found out, in some particular Body."[22]

Sprat selected Christopher Wren as the exemplar of the Royal Society and associated him with observation, hypothesis, and theory. His "Doctrine of Motion . . . the most considerable of all others for establishing the first Principles of Philosophy, by Geometrical Demonstration," is compared favorably to that of Descartes, who made "some Experiments of this kind upon Conjecture, and made them the first Foundation of his whole System of Nature." Wren, in contrast, had demonstrated "the true Theories, after they had been confirm'd by hundreds of experiments."[23] Wren himself wrote that a "hypothesis" confirmed by observed facts might be "true."[24]

Sprat's treatment of the Society's attitude toward hypothesis did not differ substantially from one of 1686 in which the Society was characterized as concerned not only with performing experiments "but also with useful Discourses concerning Physical, Mathematical, and Mechanical Theory or Observations."[25]

Similar terminological laxity characterized Oldenburg's massive correspondence, which was liberally sprinkled with references to hypotheses, theories, and laws without much by way of distinction between the terms.[26] At times there is a utilitarian Baconian vision with relatively little place for hypothesis. On one occasion Oldenburg changed his terminology from "hypothesis" to "theory" to conform to Newton's insistence that his report on colors had been erroneously characterized as a "hypothesis."[27] Statutes

governing the Royal Society indicated that members would discuss their experiments and observations as well as consider "what may be deduced from them." The Society would not commit itself to any particular hypothesis, but individual members often offered their views for discussion. Well-founded hypotheses were taken seriously.[28]

For Royal Society apologist Glanvill, hypotheses without a "history of Nature" were "but Dreams." If "we frame Schemes of things, without consulting the Phenomena, we do but . . . describe an Imaginary World of our own making." Hypotheses without facts were fictions, but they were useful when based on "events and sensible appearances." Given the current inadequacies and incompleteness of natural history, however, it was difficult to develop hypotheses and advance "natural Theory . . . much less, to fix certain Laws and prescribe Methods to Nature in her Actings."[29]

In some moods and on some occasions Glanvill took the position that "all we can hope for, as yet, is . . . the History of Things," the establishment of "general Axioms," and the making of hypotheses to be "the happy privilege of Succeeding Ages." "We have as yet no such thing as Natural Philosophy; Natural History is all we can pretend to"[30]—Glanvill's more frequently stated position was not quite so pessimistic though it emphasized the probabilistic quality of even the best hypotheses.[31]

The Virtuosi

Given the use of hypotheses in astronomy and in Cartesian physics,[32] it would have been difficult for English virtuosi, some of whom were influenced by Descartes, to avoid hypotheses entirely. Atomism and corpuscularism required hypotheses because minute particles, being invisible to the senses, had in some sense to be hypothesized. But it was the linkage of observed and experimentally produced "matters of fact" with hypothesis that most characterized the practice of the English Restoration community.

Henry Power noted that "real Experiment or Observation" was necessary to avoid error in hypotheses and conjectures and indicated that empirical work would both suggest and test hypotheses.[33] Samuel Parker, an early defender of the new philosophy, commended the Society for rejecting "all particular hypotheses" in favor of "true and exact Histories"; nevertheless, he believed that the new natural history would in time "lay firm and solid foundations to erect Hypotheses." Matters of fact might be "exact and certain," but hypotheses were "conjectures" having "uncertain (though probable) applications." Lord Brouncker's experiments on gun recoil "commanded" by the Society aimed at the "discovery of the cause thereof." Ralph Bohun, Robert Plot, and John Beale wrote of speculation, conjecture, theory, opinion, and principles to be tested by matters of fact,

experience, and experiments.[34] Causal analysis was obviously part of the Royal Society's mission from its early years.[35]

Though the distinction between fact and hypothesis and fact and causal analysis was clear, the distinction between hypothesis and theory was not. Sometimes theory implied greater certainty, sometimes it did not. Sometimes theory implied a connection with mathematics, sometimes it did not. It is thus difficult to know how to interpret John Evelyn's 1663 comment that the goal of the Royal Society was to produce "real and useful Theorie." Walter Charleton referred to the "great evidence and certainty" of Harvey's hypothesis dealing with the circulation of the blood, indicating he was "well satisfied" with its "Verity." He noted the "singular probability" of the Copernican hypothesis, which was accepted "upon grounds of as much certainty and clearness, as the sublime and remote nature of the subject seems capable of."[36] Not all hypotheses were as certain as Harvey's or as probable as that of Copernicus. Charleton, for example, felt that his investigation of the passions would not allow him to hope for "certain and demonstrable Knowledge" but thought it was "so plausible, at least, as to form an Hypothesis."[37]

Natural historians who at some times were content merely to collect and classify data, at others engaged in linking "fact" and "hypothesis." Nehemiah Grew described the philosophy of the Royal Society as "Reasoning grounded upon Experiment, and the common notions of Sense, the former being, without the latter, too subtle and intangible, the latter without the former, too gross and unmanagable." Though it was necessary to "subjoin Experiment to conjecture," much caution was required in making and "passing a Judgment" on the latter.[38] On another occasion Grew told Oldenburg, "I think I have not only conjectur'd but demonstrated many things. And if I were convinced, That those things I have said . . . , were only bare ingenuitys, I would immediately burn them."[39] There was a general, if not unanimous, understanding that facts could and should serve as bases for generating causal explanations and that various and contradictory hypotheses could be generated from the same facts.

Although the language of the "laws of nature" was not widely or frequently employed in the pre-Newtonian era by natural philosophers when referring to natural phenomena or natural facts, "law" was occasionally employed, as was "true hypothesis and "true principle."[40] In 1662, referring to hypotheses of Wren and Boyle, Huygens, a regular correspondent of Moray, wrote that hypotheses exhibited "many degrees of Probable, some nearer Truth than others." "The highest degree of probability existed when the Principles that have assumed to correspond perfectly to the phenomena which experiment has brought under observation, and further, principally, when one can imagine and foresee new phenomena which ought to follow from the hypothesis which one employs, and when one finds therein the fact corresponds to our prevision."[41]

Mathematician William Neile seems to have envisioned a full cycle of initial fact collection followed by hypothesis formulation and then hypothesis testing as a guide to further empirical research. He proposed that committees of the Royal Society consider the "possible cause or causes" of experimental results, arguing that those best qualified to do the experiments should also "steere their judgments and reason to the indagation of the causes." Experiments would shed light on the causes, and the "forming of causes" would help discover "new and unthought effects," a position not so far from that expressed by Sprat.[42]

Sir Joseph Williamson suggested that it was best to "proceed synthetically by first making the proposition what was designed to be proved, and then proceed with the experiments to make the proof." Sir William Petty, on the other hand, felt experiments were "more faithfully made and delivered, if not made to help out a theory, because that might prepossess and bias the experimenter."[43] In their disdain for earlier natural philosophy, some members moved to a crude empiricism in which facts should be piled up now with theory deferred until later, seeing premature hypotheses as creating a threat of biased experimentation. Others envisioned programs of experiment guided by hypothesis as superior to ambitious but random fact collection.[44]

Although it is clear that the Royal Society combined fact and hypothesis, neither its members nor its apologists and leadership had reached a consensus on precisely how the two should be linked. A somewhat closer examination of the views of three major Restoration virtuosi, all of whom were active in the Royal Society's affairs, underlines both the desire to link "fact" with "hypothesis" or "theory" and the uncertainty as to the nature of the linkage.

Robert Hooke

One of the most active and prolific members of the Restoration scientific community, Robert Hooke worked in a dazzling array of fields. He was involved with planetary observation, theoretical astronomy, microscopic studies, and geology as well as a host of practical inventions. Hooke is often considered a Baconian, and in some sense he was. Although he spoke of the "Incomparable Verulum,"[45] he abandoned the Baconian distrust of hypotheses, writing that even natural historians primarily concerned with compiling the facts of nature must be "acquainted with all sorts of hypotheses & theories by which the phaenomena of Nature have been Indeavored to be solv'd."[46]

Hooke distinguished between matter of fact and "philosophical conjectures on the causes" or "reasons of . . . phenomena," viewing both as vital to the Society's activities.[47] Like Sprat, Hooke noted that though the Society had "seem'd to avoid and prohibit pre-conceived Theories and De-

ductions from particular, and seemingly accidental Experiments," these "if knowingly and judiciously made are Matters of the greatest Importance, as giving a Characteristick of the Aim, Use and Significancy thereof." Without hypotheses, "many and possibly the most considerable Particulars" would be passed over "without Regard and Observations."[48] The business of the Royal Society should, in fact, include "examination of all Hypotheses and Doctrines that have hitherto been published and for trying how Consonant they are with their own assertions and experi[ments] and in what they are good & in what Defective where they have asserted truth and where falsehood and what part of them is worthy to be retained and what is absolutely false & absurd & and to be rejected, and what is of a middle nature & and deserves to be farther considered."[49]

Hooke's *Micrographia* (1665) praised the Royal Society for rejecting any "hypothesis not sufficiently grounded and confirm'd by Experiments" and lauded its efforts to "correct all Hypotheses by Sense." His own hypotheses were to be treated "only as Conjectures and Quaeries," and his discussions of "causes of things" observed were not to be viewed as "unquestionable Conclusions, or matters of confutable Science." Readers were not to expect "Infallible Deductions, or certainty of Axioms."[50]

Yet Hooke disparaged experimenters who "make no use at all of their reason and employ nothing but their senses in taking notice of matter of fact." Indeed, it was "a little below the name and dignity of Philosophers to sitt still with the bare registering of effects without an inquiry into their causes."[51] Hooke favored a procedure that began with observation, continued according to reason, and then returned to the "Hands and Eyes" in a "continual passage round from one Faculty to another." In the process, Hooke hoped "true Hypotheses" would result.[52] Some causal explanations, however, would remain merely "probable" because insufficiently supported "by Observation . . . to conclude anything positive or negative." Employing the judicial analogy, he noted that experiments "may stand like so many witnesses to give testimony of this truth or against that error. And a most severe examination of these witnesses must be made before a jury can warrantably give their verdict or a judge pronounce sentence, for branding one proposition or hypothesis as erroneous and absurd or for establishing another for a truth or axiom."[53]

Some kinds of hypotheses, however, were not even eligible for such a trial, among them speculations that could not be supported by matters of fact.[51] Hooke's *Cometa* took up the problem of dealing with competing hypotheses when needed facts or data were lacking. Here he suggested that whatever was not built on careful observation was nothing but "conjecture" and "hypothesis."[55]

Hooke also employed "hypothesis" in connection with astronomy and physics, where he spoke of both "a true hypothesis" and "probable argu-

ments."[56] He sometimes contemplated the possibility of a fact-based, mathematical, empirical philosophy that would yield a certainty roughly equivalent to that of "mathematical certainty."[57] His statement that the goal of natural philosophy was to "discover the nature and properties of bodies as well as the true causes of natural philosophy"[58] is difficult to reconcile with his more probabilistic pronouncements. In these partial contradictions Hooke represents the Restoration mainstream that connected the Baconian fact to hypothesis but remained somewhat uncertain as to the nature of the connection and divided over the certainty of the results. He was quite capable of using the word "hypothesis" pejoratively, to apply to mere speculation neither empirically derived nor tenable, or to use it to refer to an empirically derived and testable causal proposition or in connection with a mathematical theorem and proof.

Robert Boyle

Although Boyle recognized the difficulty of building "an accurate hypothesis" on "an incompleat history" of nature,[59] he was ready to develop hypotheses on the basis of the available factual data, it being "sometimes conducive to the discovery of truth, to permit the understanding to make an hypothesis . . . by examining how far the phaenomena are, or not, capable of being solved by that hypothesis." If "built upon a more competent number of particulars," hypotheses were freed from "imputation of barrenness."[60] He and his associates should "forbear to establish any theory, till they have consulted with . . . a considerable number of experiments, in proportion to the comprehensiveness of the theory to be erected on them."[61]

Boyle developed hypotheses in a many different contexts. His work on the consistency of gems, which resulted in a "Conjectural hypothesis," would first show that his hypothesis was possible and then "set down some particulars to make it very Probable." His "explication" was to be judged according to how well it fit the factual data.[62] His "Origine of Forms and Qualities" had both "historical" and "speculative" parts.[63] Boyle also indicated that hypotheses could "render an intelligible account of the causes of the effects, or phaenomena proposed, without crossing the laws of nature, or other phaenomena; the more numerous, the more various the particles are, whereof some are explicable by the assisted hypothesis, and some are agreeable to it, or, at least are not dissonant from it, the more valuable is the hypothesis, and the more likely to be true."[61] Although many atomists, corpuscularians, and other naturalists "presume to know the true and genuine causes of the things they attempt to explicate," the "utmost they can attain to, in their explications, is, that the explicated phenomena may be produced in such a manner, . . . but not that they really

are so."[65] Boyle also considered the "Requisites of a Good Hypothesis." Among them were consistency with observations and the laws of nature. An "excellent hypothesis" had additional requirements, including being the simplest one, the only one capable of explicating the phenomena, and the ability to predict future phenomena.[66]

Boyle's views on sense and reason help explain how "matter of fact" and hypothesis were linked. Reason, the "superior faculty," judged what conclusions could and could not be "safely grounded on the information of the senses, and the testimony of Experience."[67] Explanation and hypothesis required that reason be "duly exercised" on "matters of fact." Only in this way could one hope to gain knowledge of "unobservable truths."[68] When reason judged which of "two disagreeing opinions" was "most rational," it "ought to sentence" what is "preferred" by reason, "furnished, either with all the evidence requisite or advantageous to make it give a right judgement . . . , or, when that cannot be had, with the best and fullest information, that it can procure."[69] Experience was therefore "but an assistant to reason . . . the understanding remains still the judge, and has the power or right to examine and make use of the testimonies presented to it. . . . This prompts me to illustrate the use of reason by comparing her to an able judge who comes to hear and decide cases. . . . When an authentick and sufficient testimony has cleared things to him, he then pronounces according to the light of reason he is master of; to which the witnesses did but give information, though that subsequent information may have obliged him to lay aside some prejudicate opinions he had entertained before he received it."[70]

Boyle's terminology was not consistent. Sometime he spoke of hypotheses, at others of "theory," "conjecture," "explication," or even "conjectural hypothesis." Hypotheses might refer to large-scale systems of natural philosophy, such as the Peripatetic, Cartesian or Epicurean, or to some facet of his own or others' experimentally based work.[71] Boyle occasionally employed the language of "theory" but made it clear that such "superstructure[s]" ought to be "looked upon only as temporary ones; which though they may be preferred before any others, as being the best in their kind that we have, yet they are not entirely to be acquiesced in, as absolutely perfect, or uncapable of improving alterations."[72] Given his belief that the generalizations of natural philosophy were probable and always subject to modification, Boyle, like Sprat and Hooke, insisted on not being overly forward in establishing general principles and universal axioms.[73] In view of both the limitations and strengths of the human mind and the way in which reason operated on sense data and matters of fact, all theories, generalizations, or hypotheses were necessarily probabilistic.[74]

Boyle's experimental philosophy included both confident belief in "matters of fact" and the deployment of hypotheses of varying degrees of

probability. Like many other Restoration-era naturalists, he was led in the direction of nonessentialist natural philosophy, for hypotheses and explanations, however well grounded, remained probable and tentative.

John Wallis

Mathematician John Wallis, Savilian Professor of Geometry at Oxford and a founding member of the Royal Society, like most English virtuosi wished the Royal Society to "contribute . . . conjectures, advice, and reasoning" as well as observations and experiments. Experiment would both furnish "the matter to determine ye Hypothesis" and "be the best judge" of the hypothesis in question.[75]

When Wallis presented his "hypothesis about the flux and reflux of the Sea," he promised to discuss it modestly "as a conjecture to be examined, and upon that examination rectified if there be occasion, or rejected if it will not hold water." He contrived experiments "to illustrate" the hypothesis but emphasized that the "clearest evidence" would come from celestial observations. His "discourse" was therefore to be considered "only as an Essay of the general Hypothesis," which would be "adjusted" as the still wanting "General History of Tides" developed. He would therefore not insist on "the certainty of it." His hypothesis would eventually "stand or fall, as it shall be found to answer matter of fact." "For where the Matter of Fact well agreed on, it is not likely that several Hypothesis should so far differ." Although Wallis used "hypothesis" most frequently in connection with his work on tides, he also spoke of that work as "surmise," "conjecture," and "essay." Oldenburg labeled it a "theory."[76]

Wallis also discussed hypothesis when requested to comment on Leibniz's *Hypothesis physica nova*. He responded evasively, suggesting delay in assenting to new hypotheses, even those "proved by the evidence of the eyes," until there was time to assess arguments on both sides. The truth of hypotheses emerged slowly. The Leibniz hypothesis, not yet proved "by ocular inspection nor by certain demonstration," would, if "founded on true reasoning . . . at last . . . find a place in the minds of those who philosophize freely."[77] For the most part, Wallis seems to treat hypothesis in terms of empirical confirmation but probably did not entirely distinguish empirical support from mathematical or other rational proofs.

In seventeenth-century English natural philosophy some real conceptual confusion seems to have remained between hypothesis as empirically derived and empirically disconfirmable, probabilistic, causal statement and hypothesis as mathematical proposition subject to mathematical proofs. Most of the confusion, however, was linguistic rather than conceptual. In one sentence hypothesis was fiction or at least conjecture, neither empirically derived nor tested. In another it meant roughly what scientists

today mean. Yet behind the verbal confusion is a fairly clear understanding of what constitutes a scientifically appropriate hypothesis and of its probabilistic nature. There was, however, some genuine disagreement about whether particular areas of empirical inquiry were yet ready for treatment by hypotheses. And there was fear of premature acceptance of or excessive dependence on newly proposed hypotheses. There was also marked distrust of large systems of hypotheses or universal theories as running far beyond existing fact-gathering and processing resources. Although the English scientific community was neither unanimous nor consistent in its expressed attitudes toward hypothesis, the combination of "fact" and "hypothesis" became the most characteristic feature of Restoration scientific practice.[78]

Newton and the Newtonian Era

Boyle and Hooke combined Baconian natural history based on morally certain "matters of fact" with more or less probable hypotheses. Although Newton shared their Baconian insistence on well-observed and well-recorded experimentally produced phenomena, he frequently rejected hypotheses as "suppositions," instead attempting to employ mathematically structured arguments to produce what he took to be universally valid statements. Newton claimed that his conclusions, which he often labeled "theories," enjoyed a certitude greater than that of hypotheses because directly derived from experimental facts. From one vantage point we may view Newton as more Baconian than Boyle or Hooke; from another he participated in the mathematical physics of Galileo and his successors and in the physico-mathematical tradition of mixed mathematics.[79] In any event, his successes in deducing "theory" from facts (he used the term "phenomena"), facts now treated mathematically, played an important role in the transformation of English natural philosophy. Here we focus on those instances where he appeared to differ most from his English contemporaries.

We begin with Newton's defense of his 1672 "theory" of colors. Although Newton, his critics, and his supporters were equally wedded to experimental "facts," there was considerable disagreement on the relationship of the "facts" to his "theory" as well as on how to characterize his results. "You know the proper method for inquiring after the properties of things is to deduce them from experiments; and I told you that the theory, which I propounded, was evinced to me, not by inferring 'tis thus because not otherwise, that is, not be deducing it only from a confutation of contrary suppositions, but deriving it from experiments concluding positively and directly. The way therefore to examine it is by considering whether the experiments . . . do prove those parts of the theory, to which they are ap-

plied, or by prosecuting other experiments, which the theory may suggest for its examination."[80]

Newton's most vocal critic, Hooke, rejected Newton's claims of certitude, suggesting that his own hypothesis on light explained the experimental facts equally well. Newton was insulted when his "theory" was labeled a "hypothesis," insisting that he had presented "nothing else than certain properties of light." He preferred the Royal Society to have "rejected them as vain and empty speculation" rather than have acknowledged them as "hypotheses." If the "possibility of hypotheses" were the "test of truth and reality of things, I see not how certainty can be obtained in any science."[81]

Yet for Huygens, too, Newton's theory of colors was a hypothesis, though a "very probable" one, in which the "experimentum crucis" "confirms it very well." Huygens wrote Oldenburg, "What you have put in your late Journals from Mr. Newton confirms still further his doctrine of colors. Nevertheless the thing could very well be otherwise, and it seems to me that he ought to content himself if what he has advanced is accepted as a very likely hypothesis."[82] Oldenburg, who began by calling Newton's proposition a "hypothesis," changed to "theory."[83] If for some natural philosophers, such as Boyle, terms such as "theory," hypothesis," and conjecture" might be used interchangeably, for Newton they could not. Newton remained angry at attempts to offer "an hypothesis to explain my theory." However labeled, Newton's experiments, according to James Gregory, would "cause great changes throughout all the body of natural philosophy, by all appearances, if the matter of fact be true, which I have no ground to question."[84]

In the *Principia* (1687) Newton elaborated the view that the principles of natural philosophy and scientific facts were inseparably bound together. He proclaimed even more emphatically, "Hypothesis non fingo." He would "frame" or "feign" no "hypotheses."[85] Whatever was "not deduced from the phenomena" was "an hypothesis" and had "no place in experimental philosophy." Particular propositions were inferred from the phenomena or observed facts and afterward rendered general by induction. Gravitation was not a hypothesis because its principles had been deduced from observed facts. A hypothesis was simply "whatever is not deduced from the phenomena" and, for Newton, it had a very low status indeed.[86]

What Newton had "deduced" from the body of "facts" itself took on the quality of "fact" and became connected to universal truths and the laws of nature. With Newton, fact and theory were so closely connected that the conclusions or "theories" drawn from "facts" were treated as true. The association was further accentuated by Newton's mathematical approach. As Newton's mathematical representation replaced verbal description, it diminished the sense of human fallibility. Newton's *Principia* over time pro-

duced a change in scientific sensibility. The mathematization of nature contributed to a decline in courtroom analogies in dealing with matters of fact and a corresponding increase in the language of the physical laws.[87] The development of a discourse of the laws of nature in the Newtonian sense did not displace a discourse about facts. Rather, the discourse became more refined as philosophers and experimenters came to talk about facts, theories, hypotheses, and laws in more nuanced ways.

The quarrel over "hypothesis" between Newton and his contemporaries was in one sense simply linguistic. Newton sought to preserve the older meaning of the word, synonymous with supposition or conjecture, for propositions about empirical matters that were not themselves derived from or confirmable by factual observations or experiments. He reserved "theory" for those propositions that were properly, that is factually, derived and confirmed, propositions that others were now calling hypotheses in the newer sense. He also put special emphasis on the care needed in hypotheses or theory construction, that is, on the need to lay a careful factual foundation at the induction stage, but Hooke and others had made that point as well. Along this dimension the seeming disagreements between Newton and others are largely illusory or are arguments about whether rival hypotheses have been equally persuasively induced and/or confirmed.

Along another dimension, however, the disagreement is more serious. Newton may well be taken as claiming that both theories in his sense and factual findings can rise to something comparable to mathematical certainty, that is, to true and invariable laws of nature. Alternatively, it might be argued that Newton was insisting that at any given time the natural philosophy program should be limited to investigating those realms of fact in which quantification or measurement was possible.

Newton's stunning achievement had an enormous impact. Even Locke, whose probabilistic empiricism resembled Boyle's, viewed Newton's achievements as extraordinary. "Mr. Newton has shown, how far mathematics, applied to some parts of nature, may, upon principles that matter of fact can justify, carry us to the knowledge of some . . . particular provinces of the incomprehensible universe." If others could provide "so good and clear an account of other parts of nature . . . we might in time hope to be furnished with more true and certain knowledge."[88] For the most part, however, Locke was content to link matters of fact to less certain hypotheses. Few were expected to accomplish what the "incomparable Mr. Newton" had done.

Newtonians changed natural philosophy by joining observed and experimentally derived facts with mathematical physics. The "laws of nature" became indissolubly linked to "facts," and these, in part because they were expressed in mathematical form, took on some of the certitude associated

with mathematics. Mathematics and mathematical physics had always been a concern of the Royal Society and the English scientific community more generally, but their prestige was now enhanced. Experimental facts expressed mathematically were seen as having produced laws of great certitude and universality. John Keill emphasized the application of mathematics to natural philosophy, "which is founded upon observations and calculations, both which are undoubtedly the most certain principles, that a Philosopher can build upon . . . for without observation we can never know the appearances and force of nature, and without Geometry & Arithmetick we can never discover, whether the causes we assign are proportional to the effects we pretend to explain."[89] Newton's achievements set the standard of what had been and what might be accomplished by natural philosophers.

Newton's success in mathematizing nature did not diminish English enthusiasm for natural history. Fact gathering by observers, explorers, travelers, and experimenters continued, and facts were collected, classified, and situated in hypotheses of varying degrees of probability. In many respects, the Royal Society in the eighteenth century continued in much the same path as it had in the seventeenth, practicing a Baconian empirical science that emphasized facts. Many members would have agreed with Hans Sloane, president of the Society, who insisted that "Knowledge of Natural-History, being Observations of Matters of Fact, is more certain than most Others, and . . . less subject to Mistakes than Reasonings, Hypotheses, and Deduction are. . . . These things we are sure of, so far as our Senses are not fallible." "These matters of Fact being certainly laid down" might "perhaps afford some Hints for the more clear Reasonings and Deduction of better heads."[90] For Sloane, hypotheses and deductions remained less certain than properly observed fact. The ambivalent and sometimes hostile attitude to some types of hypotheses continued, perhaps reinforced by Newton's pronouncements. The English way of "philosophizing" was described as "not to sit down in one's study, and form an hypothesis, and then strive to wrest all nature to it, but to look abroad into the world, and see how nature works; and then to build upon certain matters of fact."[91] In the Royal Society much attention continued to be given to the facts of mixed mathematics, that is, the facts of astronomy, geography, and hydrography, which were being communicated to it from all over the globe. As in the past, optics, pneumatics, and meteorological experiments were of great importance. General philosophical speculation remained outside the Society's activities. Instrument improvement continued apace, making possible growing quantification in physics. As the Society's early members had forecast, new and better instruments were responsible for the development of previously unknown and previously unknowable "facts." Richard Sorrenson has even suggested that

the eighteenth-century Royal Society was characterized by a "worship of facts."[92]

This is not to say that nothing had changed. Some natural historians modified their language in the post-Newtonian decades. John Woodward, for example, claimed that his "reflections" were "founded entirely upon those Circumstances, Phaenomena, and Experiments" and were "in truth so many Deductions from them." They were "therefore as much Matter of Fact" as "those are, and to be rely'd upon with equal Certainty." For Woodward, there were two kinds of proofs, "those which [are] only probable and which we have some reasonable intimations, but not absolute and demonstrative certainty," and "those whereof we have a plain and undeniable Certainty; those which flow directly and immediately from the Observations."[93] His own, he thought, were of the second variety and therefore as certain as "facts." Employing the beyond-reasonable-doubt language associated with suitably substantiated matters of fact, he found his deductions to be "so incontestible, as to leave no Room for a Man of Understanding to doubt of it."[94] A rather cantankerous naturalist, Woodward suggested that those who refused to draw conclusions from observed facts "might well be reputed very fantastic and extravagant."[95]

For many post-Newtonians, generalizations from fact were becoming so closely enmeshed with the "matters of fact" from which they had been "deduced" that they too might be accepted as "facts" or "truth." The "facts" of Boyle, Hooke, Glanvill, Sprat, and Oldenburg, which had been largely deployed in probabilistic hypotheses, now might be found associated with universal "laws of nature," to which a greater certainty was ascribed than most seventeenth-century virtuosi would have ascribed to even the best-crafted hypotheses.[96]

Some of these changes are exemplified in the works of Ephraim Chambers, author of the *Cyclopedia or An Universal Dictionary of the Arts and Sciences,* and Oliver Goldsmith, the author of a popular survey of experimental philosophy. Chambers wrote, "The latest and best Writers are for excluding Hypotheses and standing wholly on Observation and Experiment." Citing Newton, he noted, "Whatever is not deduc'd from Phaenomena, . . . is a Hypothesis" and has no place in "Experimental Philosophy."[97]

Goldsmith constantly used expressions such as the "observation of facts" and the "facts of nature." "Facts" are taken as givens, as true without the need to examine whether or not they were well founded. There was, therefore, less need constantly to refer to witnesses and credibility. Newton is seen as having ushered in a new era, effecting "what his predecessors . . . aimed at; namely the application of geometry to Nature, and by uniting experiments with mathematical calculations, discovered new laws of Nature, in a manner at once precise, profound, and amazing."[98]

Eighteenth-century language typically implied a divine legislator who had established "laws," inviolable except by divine abrogation. Agreed-on experimental "facts" could sometimes be treated mathematically in order to comprehend at least some of these "laws." Natural facts, which earlier had been evidence for the being and existence of the deity, now also became linked to his mode of operation. In the hands of Newton, the "facts of nature" were linked to God's universal laws.

At this point facts had come to play several roles.[99] Particular, well-evidenced facts might be related to hypotheses or suppositions of varying degrees of probability, might be simply collected and perhaps cataloged and classified, or might result in principles or laws of universal validity. The language of theory and hypothesis did not stabilize. For some, theory and hypothesis remained interchangeable; for others, theory implied something more certain. Perhaps we can speak of a continuum, from conjecture, to hypothesis, to theory, axioms, and laws of nature. "Hypothesis," the term most frequently used in the late seventeenth century by those hoping to derive principles, whether probabilistic or certain, from "fact," is partially replaced in the eighteenth century by "theory" or "law."

Harvey Wheeler and Rose-Mary Sargent suggest that scientific principles and legal principles were developed by similar procedures. They argue that lawyers culled cases to arrive at legal principles in much the same way that naturalists derived the principles of natural philosophy.[100] It is true that the virtuosi quickly adopted legal notions of how facts might be determined. But jurors, the fact finders in law, were not given a role in enunciating legal principles. Judges were to declare legal principles from the cases, but "cases" were not facts. The methodology used by judges in deriving these principles does not appear to be related to the forms of empirical hypothesis or theory construction we have encountered in the study of nature. Judges certainly did not think of themselves as going *from* fact *to* law or as confirming laws by empirical inquiry. Rather, they saw precedents as particular normative pronouncements from which the more general normative principles of the English people lying behind them might be teased out by reason. It is thus difficult to see how Coke's distinction between the artificial reason of the law, accessible only to judges and lawyers of long experience, can be harmonized with Boyle's and the virtuosi's use of reason as a tool of empirical inquiry. The laws or principles of nature were precisely natural, not manmade, and thus the same throughout nature. With the exception of those whose legal thinking was particularly shaped by natural law, seventeenth-century lawyers recognized that different nations operated according to different legal principles. Sir Matthew Hale distinguished the unchanging laws of nature from the mutable laws of man.[101] The judge's job was indeed to induce, but to induce the moral rules the English had chosen to enact into judi-

cially enforceable statements. Although the virtuosi derived their methods of establishing matters of fact from the law, they did not regard themselves as engaged in enunciating authoritative or normative principles. The "laws of nature" appear to have been derived from Christian and mathematical heritages rather than a legal one.

The most commonly practiced form of natural philosophy in England during the Restoration era and beyond dealt in matters of fact and hypotheses of varying degrees of probability and believability. "Fact" had become a constituent part of the vocabulary of natural philosophy and has remained central to scientific vocabulary and practice. The combination of facts established by observation and experiment with probable hypotheses was a significant factor in moving English natural philosophy in an empirical direction. The introduction of the category "fact" as a central and constituent part of Restoration scientific endeavor and practice resulted in a readjustment of "conjecture," "hypothesis," and "theory" in English natural philosophy. This readjustment, however, was unstable. The concept "fact" proved compatible with a variety of positions on the nature and function of hypothesis and theory.

The Language of Natural Philosophy

Although naturalists did not always practice what they preached, we must take seriously their frequent statements against ornamentation and in favor of a plain and undogmatic style.[102] They attacked scholastic language, appropriating and elaborating the humanist critique of scholasticism. The linguistic practices of the alchemists and the philological, etymological, emblematic, and fabulous embedded in traditional natural history were also targets. Still another was the copious and highly ornamented language associated with Renaissance poetry and rhetoric.

In this period rhetoric was conceptualized in two quite different ways. The first, associated with Aristotle and Cicero, separated logic from rhetoric. The second, derived from the reorganizations of Agricola, Melanchthon, Ramus, and others, reshuffled traditional material to distinguish "rhetoric" from "dialectic," to produce a kind of rhetoricized logic. In the reformulated schemes, invention and disposition and thus argumentation were assigned to "dialectic," leaving rhetoric as little more than figures of speech. Because the two positions existed side by side, it is difficult to know whether critics of rhetoric were attacking the larger conception of rhetoric as argument and style or only excesses of style.[103]

Although the Restoration naturalists did not originate the factual style, they were emphatic and persistent in their stylistic pronouncements. Their severest attacks focused on rhetoric defined as style rather than "invention" or "judgment," now comfortably ensconced in "dialectic." The

"facts" of the naturalist, no less than the facts of the lawyer, the historian, and the chorographer, were to be described in unadorned English. The naturalists, however, pushed that ideal considerably further than other advocates of the plain style, arguing that language describing nature should be brought "back again to our very Senses from whence it was first derived to our understandings."[104] Sprat proclaimed that the Royal Society "indeavor'd to separate the knowledge of Nature, from the colours of Rhetoric . . . this vicious abundance of Phrase, this trick of Metaphor, this volubility of Tongue." The remedy was "a close, naked, natural way of speaking; positive expressions; clear senses; a native easiness, bringing all things as near to Mathematical plainness as they can; and preferring the Language of Artisans, Countrymen, and Merchants, before that of Wits, or Scholars."[105]

Sprat's statements were underlined in the Royal Society's statutes, which required, "In all Reports of Experiments to be brought into the Society, the Matter of Fact shall be barely stated, without any Prefaces, Apologies, or Rhetorical Flourishes."[106] The facts of natural history must be recorded without "superfluousness in the Words. In the Choice of which, there ought to be great Care and Circumspection, that they be such as are shortest and express the Matter with the least Ambiguity, and the greatest Plainness and Significancy, not augmenting the Matter by Superlatives, nor abating it by Diminuitives, . . . avoiding all kinds of Rhetorical Flourishes, or Oratorical Garnishes, and all sorts of Periphrases or Circumlocutions."[107] John Ray, John Wilkins, Robert Boyle, Sir William Petty, Joseph Glanvill, John Ray, and Francis Willughby were among the many naturalist advocates of a plain unadorned style.[108] All the "discourses of fact" favored "perspicuity" and "plainness." Embellished language was, more often than not, associated with lies and deception and/or fiction and romance or with rhetorical excess. Highly ornamented language obscured matters of fact by intentionally or unintentionally insinuating falsehood or error.

Another feature of fact-oriented scientific discourse was the preference for first-person reporting.[109] Immediacy and vividness too were among the desired characteristics of observations and experimental reports, that is, of the language of "facts." As we have seen, suspicion of secondhand or hearsay reports was characteristic of all the discourses of fact. A focus on the particular time, place, opportunity to observe, and circumstances of a specific event characterized the scientific report of natural facts as well as the reliable news report, the description of a historical event, and the testimony of a faithful witness in a law court.[110]

Yet the virtuosi did not entirely discount the skills of persuasion. Sprat was hired to write an account of the Royal Society primarily because of his literary skill, and he himself noted its apologetic as well as its historical

character. Oldenburg counseled New England members "to instill the nobleness of this institution and work with your best Logicke and Oratory, into the minds of all your friends and acquaintances there."[111] Rhetoric might legitimately and profitably be used to promote the goals of natural philosophy but marred accurate statements of "fact."

Hypothesis, Language, and Discourse

Hypotheses and other forms of causal explanation played a role in the language of natural philosophy. In contrast to matters of fact, hypotheses emphasized probability and, therefore, tentative language. Hooke insisted hypotheses must not be dogmatically stated. Since "demonstration" was unattainable in physics, there must always be "room for differences of opinion." Hypotheses therefore should not be delivered with "full confidence."[112] When Newton insisted that his "theory" of colors was no hypothesis, fellow virtuosi had difficulty accommodating to his assertive language.

The marriage of "fact" and "hypothesis" and their epistemological status generated a set of linguistic norms. The firsthand simple language of fact was expected to lead to agreement beyond reasonable doubt. The language of hypothesis should lead to the polite expression of differences over what could not be certain. The virtuosi rejected the academic tradition of formal, scholastic disputation and the forms of rhetorical debate introduced in the universities during the sixteenth century, although academicians who adopted the new discourses of fact were welcomed by the scientific community and played a substantial role in creating it. It was thus not the scholar but the disputation and other conflictual modes of discourse that were rejected. The norms of plainness and tentativeness were linked respectively to the adoption of "fact" and "hypothesis." The impact of the epistemology of fact and hypothesis on scientific language and decorum must be taken into account in evaluating the influence of humanist, courtly, and gentlemanly conventions.[113]

We have already noted that expertise and opportunity to observe were important to the Royal Society. Deference to rank that was so much a part of the Italian court-oriented scientific environment was largely, if not completely, absent from English scientific circles. Absence of a substantial royal and explicitly aristocratic presence at Royal Society meetings meant that it was unnecessary to defer to the opinions or research interests of the most socially prominent.[114]

Aristocratic and courtly life was immersed in the language of subservience and flattery. The tradition of the courtesy manual, central to Shapin and Schaffer's conception of normative scientific behavior, emphasized the need for courtiers to beguile with "salutary deception," cre-

ating a "veil of pleasure" by adorning language with "shady fronds and strewing it pretty flowers."[115] Linguistic reticence, circumlocution, ambiguous and embellished language, and the suppression of criticism and information so as to maintain aristocratic honor, though constant features of court life, were not admired or adopted by the virtuosi. Success in courtly civil society required "sprezzatura," a practiced but artificial virtuosity that appeared natural and required mastery of the rhetorical skills necessary to fashion oneself into a number of guises as the situation required. There was little that was straightforward about the language of the gentleman-aristocrat as embodied in the courtier manuals, and Sir Robert Moray, himself a courtier, made it very clear that the languages of the courtier and the philosopher were quite different.[116] It is true, however, that the literary academies that sprang up in Italy and elsewhere during the sixteenth and seventeenth centuries provided a nonacademic venue where scholarly and intellectual topics were cultivated in an atmosphere that prized civility. These no doubt played a role in providing a linguistic and behavioral norm for the newer scientific society.

The language of the virtuosi also probably owes something to the concept of the "Republic of Letters" fostered by seventeenth-century scholars of differing nationalities, religions, and political persuasions.[117] It was recognized early that scientific progress would require avoidance of the most divisive religious issues. The 1645 group, the Wadham group, and the Royal Society all excluded religious and political topics.[118] Influenced by the international traditions of humanism and antiquarianism and a vision of natural philosophy as transcending partisan political and religious differences, the English scientific community adopted a style of writing and discourse that fostered the broadest possible communication.

English latitudinarian religious views, as I have suggested elsewhere, also contributed substantially to and overlapped with the norms of Restoration scientific discourse.[119] For the latitudinarian, two types of speech and behavior were to be avoided. The first was that of the dogmatist, sure of his opinions and willing to force them on others; the second, the language of the "enthusiast," whose religious experiences and inspiration led to language couched in mystery and inspired by a certainty not amenable to reason or evidence. Reaction to these linguistic styles, prominent during the civil war and Interregnum years, resulted in the articulation of an alternative norm for religious discourse, promoted primarily by those desiring a less persecuting and less dogmatic church and a more rational approach to religion. This movement came to fruition during the Restoration. Latitudinarians, relatively feeble politically during the Restoration, came to control the established church after 1688.

Arguing that most religious doctrines were only probable and therefore open to doubt, the latitudinarians, who were mostly Anglicans, espoused

polite and tentative language for expressing religious disagreement. Some of the most vociferous of the latitudinarians were to be found among the founding members of the Royal Society.[120]

The connection between Restoration natural philosophy and latitudinarianism was noted and applauded by Glanvill and Sprat, who emphasized the mutually reinforcing aspects of their epistemologies and modes of discourse. Glanvill even suggested that natural inquiries were a remedy for religious dissension because such inquiries "dispos'd mens Spirits to more calmness and Modesty, Charity, and Prudence in differences of Religion, and even silence disputes there."[121] Sprat announced that the new philosophy bred men "invincibly armed" against the "enchantments of enthusiasm." For John Wilkins, latitudinarian and virtuoso, polite discourse was essential, "it being utterly impossible . . . that we should always agree in the same apprehension of things. If upon every difference men should think themselves obliged to prosecute matters to the utmost height and rigour, such eager persons may easily from hence be induced to have recourse to Arms . . . and . . . it will be impossible to end their differences. . . . And thus would men grow wild and savage, the benefits of Society would be lost, and mankind destroyed out of the world."[122]

The Restoration naturalist, like the latitudinarian, was envisaged as possessing Christian humility and recognition of mankind's limited abilities. In the scientific realm, matters of fact might reach the level of moral certainty. So would the basic principles of natural religion and the central Christian doctrines. But other claims could not be substantiated with sufficient certainty to make authoritative and dogmatic pronouncements. Whether religious or scientific, probabilistic conclusions required probabilistic language and polite discourse.[123] All opinions and hypotheses should be heard and examined. Individuals rather than an authoritative collectivity should make judgments about them. The Royal Society made no official pronouncements even in the case of the Copernican hypothesis, on which most members agreed. The "Character of a True Philosopher" required "men, whose minds are so large, are in a far better way, than the Bold, and haughty Assertors." The "plain, industrious Man" made a better philosopher than "high, earnest, insulting Wits, who can neither bear partnership, nor opposition." Dogmatists were "satisfied, too soon . . . they love not a long and a tedious doubting, though it brings them at last to a real certainty." Royal Society naturalists, in contrast, were "well practis'd in all the modest, humble, friendly Vertues; should be willing to be taught, and to give way to the judgment of others."[124] The norms of scientific and latitudinarian discourse clearly were interdependent.

The model scientific discourse of the Restoration era was thus a compound of languages thought appropriate to "fact" and to "hypothesis." It was reinforced by hostility to the adversarial practices of scholastic dis-

course, a distrust of rhetorical and poetic language, and adoption of some elements of the gentlemanly norm and the traditions of humanist academies and the "republic of letters." It was informed as well by the latitudinarian response to the intense and destructive religious experience of previous decades.

Conclusion

At the beginning of seventeenth century the "scientific fact" did not exist. With the Restoration, well-supported "matters of fact," whether alone or in the company of "hypothesis," played a major role in the research program of the Royal Society. By the beginning of the eighteenth century facts had become central to English natural philosophy and even held out the promise of providing a basis for comprehension of the "laws of nature."

Initially employed to deal with human actions and deeds, "fact" was self-consciously adopted to the study of nature first by Bacon and subsequently by the new empirically oriented philosophers. Bacon's role in transforming the "human fact" into the "scientific fact" was supplemented by an English-language, descriptive, chorographic tradition in which human and natural "things" and "phenomena" were observed and recorded together using the same procedures and mental processes as those employed by other fact-oriented disciplines and genres.

Royal Society discourse concerning natural "matters of fact" shared with the other "discourses of fact" features derived from their legal origin—the focus on witnesses, the rejection of hearsay, the criteria for evaluating witnesses, and the aim of achieving the probabilistic truth of well-witnessed events. There was an emphasis on particular events and occurrences, whether ordinary or marvelous, observed or manmade. Breaking down the distinction between art and nature, naturalists seeking the truth of natural facts might create and repeatedly observe facts by experiment.

The recent work of Simon Schaffer and especially of Steven Shapin on the social history of truth has required special attention because their emphasis on the role of the code of the aristocrat and gentleman in the making of the Restoration scientific ideal is somewhat at odds with my own. In connection with the concept "fact" or "matter of fact," I have stressed the shared features of Restoration natural philosophy and other preexisting and contemporaneous discourses of fact, especially that of the law, rather than the uniqueness of natural investigation or aristocratic norms within natural philosophy. Although not denying that social status played a role in knowledge making, I suggest that a somewhat lower social threshold than gentleman was epistemologically significant in the production of believable facts. Skill and experience played a greater role in the creation of

the model of the scientific investigator than birth, and mutual trust and civility among investigators increased once fact moved beyond the contentious, self-interested setting of the court. Indeed, the work of Lawrence Klein on the development of "politeness" in the eighteenth century should alert us to the potential conflict between gentlemanly and scientific culture.[125]

In natural history and natural philosophy, as in other discourses of fact, fact was opposed to "fiction," romance, and the imaginary. Natural philosophers contrasted "facts" sufficiently evidenced by credible witnesses with speculation, whether labeled "hypothesis," "conjecture," or "inference." Naturalists remained somewhat ambivalent, or at least not completely united, about the value and nature of hypothesis. Most virtuosi favored its use, though some considered it premature. Increasingly, hypothesis became the constant companion of "fact," and the combination of fact and hypothesis became the dominant mode of English natural philosophers of the late seventeenth century. Some argued that facts were probabilistically true and thus believable but that hypotheses remained speculative and therefore tinged with fiction. Others viewed hypotheses as securely based on or deduced from facts rather than fictional. Hypotheses, however, were subject to confirmation and might be wrong or incomplete. In some instances the conclusions drawn from facts might be labeled "theory" or even "laws of nature" rather than "hypothesis." Unlike "fact," the concept "hypothesis" was not linked to legal traditions of thought. It owed much to long-standing astronomical and other scientific practice. The concept "law of nature," which Newton associated with experimental fact, was indebted both to mathematical traditions and to Christian concepts.

The linguistic standards of scientific discourse were shaped by new concerns for "fact" and "hypothesis." The discourses of fact moved in the direction of a relatively unembellished prose style. The felt need for a language appropriate to the presentation of necessarily uncertain hypotheses, along with such other features of Restoration life as latitudinarianism and the idea of a "republic of letters," shaped the discourse of the Royal Society, a discourse different from the strategic elegance prescribed by the manuals of courtesy and the contentiousness of the scholastic disputation and humanist debate.

"Matter of fact" first meant a category of allegations subject to proof by adequate witness testimony. The evidence for a matter of fact might or might not support "moral certainty" of that fact. Many matters of fact failed that test—which made some matters of fact more believable than others. Contrary to modern usage, in the seventeenth century there might be true, false, or relatively uncertain facts or matters of fact. By the early eighteenth century, however, we begin to find two diverging usages. The first, the one we have just described, treats "fact" or "matter of fact" as a

matter at issue subject to empirical proof; the second implies that anything appropriately labeled "fact" was already established as true. In this second usage the notion of a fact subject to reasonable doubt or a "false fact" became a contradiction in terms. Over time, facts, at least in the realm of nature, were becoming "true facts." During much of the seventeenth century the "facts" of the naturalists were not very different from those of other discourses. As the new philosophy gained prestige, so did the "facts" on which it was built. "Matters of fact" as issues turned into "facts" as outcomes.

The elements that brought about this change can be seen developing in the seventeenth century. Centrally involved are the increasing emphasis on the investigation of concrete, particular events, the importance of eyewitness testimony, the critical role of evaluation of such witnesses and their testimony, the open or public character of inquiry, and the development of a reporting language. Enhanced observational and measurement technologies were also significant. In all these matters natural philosophers may well have enjoyed one crucial advantage. The experiment allowed the controlled enactment of a particular matter of fact at a chosen time and place in the presence of a number of high-quality witnesses whose collective testimony could be recorded immediately and subjected to subsequent reconfirmation.

There is little doubt that the creation of the "scientific fact" marked a fundamental change in English natural philosophy. Yet it is important to keep in mind that science was only one of the "discourses of fact." Natural philosophy both "borrowed" from other disciplines and in turn influenced them. If natural philosophy assimilated the well-known and culturally legitimate category "fact" from the human sciences of law and history and used that concept to legitimize a new kind of natural philosophy, in time it was the "scientific fact" that would further legitimate the increased use of facts outside the natural sciences. In the hands of John Locke, "fact" would provide one of the foundations of all empirical knowledge. By the early eighteenth century "fact" was so widely deployed in so many diverse enterprises—legal, historical, religious, and scientific—that we can reasonably speak of England as a "culture of fact."

nized as having been "brought forth by the common Instruments of Nature." Members were reluctant to assent about "future contingencies" because they were "rigid, in examining all particular matters of Fact." Sprat, *History of the Royal Society*, pp. 359–360.
74. See, for example, *Wonders from the Deep or a true and exact Account and Description of the Monstrous Whale* (London, 1677).
75. *The Marine Mercury, or, A True Relation . . . of a Man-Fish* (London, 1642); James Grant, *The Newspaper Press*, 2 vols. (London, 1871), I, 35–36.
76. John Edwards, *Cometomantia* (London, 1684). See Sara Gentuh, *Comets, Popular Culture, and the Birth of Modern Cosmology* (Princeton, 1997).
77. *Royal Impartial Mercury*, June 9, 1682; Sommerville, *News Revolution*, p. 62. The *Domestick Intelligence* occasionally reported on the activities of the Royal Society and its members. Sept. 19, 1679, and Oct. 31, 1679.
78. Hunter and Wood, "Towards Solomon's House," pp. 59–60.
79. *Athenian Gazette*, May 12, May 19, 1691; preface to vol. VI, Dec. 1, 1691–Jan. 30, 1692.
80. Ibid., vol. 4, Nov. 17, 1691. See Atkinson, *Scientific Discourse*.
81. *True Protestant Mercury*, June 10, 1681.
82. Obadiah Walker, *Of Education, Especially of Young Gentlemen* (Oxford, 1673), pp. 248–249.

Chapter 5: The Facts of Nature I

1. But see R. S. Westfall, *Force in Newton's Physics* (New York, 1971); Norma Emerton, *The Scientific Reinterpretation of Form* (New York, 1984); Jan Wojcik, *Robert Boyle and the Limits of Reason* (Cambridge, 1996); Barbara Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983); Lorraine Daston, *Classical Probability in the Enlightenment* (Princeton, 1988); Ian Hacking, *The Emergence of Probability* (New York, 1975); Margaret Osler, "From Immanent Nature to Nature as Artifice: The Interpretation of Final Causes in Seventeenth-Century Natural Philosophy," *The Monist* 79 (1996), 388–407.
2. Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, 1985); Shapin, *The Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, 1994); Peter Dear, "Miracles, Experiments, and the Ordinary Course of Nature," *Isis* 81 (1990), 663–683; Dear, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago, 1995); Lorraine Daston and Katherine Park, *Wonders and the Order of Nature, 1650–1750* (Cambridge, Mass., 1997). See also Daniel Garber, "Experiment, Community, and the Constitution of Nature in the Seventeenth Century," *Perspectives in Science* 3 (1995), 173–205.
3. See Arno Seifert, *Cognitio Historica* (Berlin, 1976); Paolo Rossi, "Hermeticism, Rationality, and the Scientific Revolution," in *Reason, Experiment, and Mysticism in the Scientific Revolution*, ed. M. L. Bonelli and William R. Shea (New York, 1995), pp. 255–274; Antonio Perez-Ramos, *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition* (Oxford, 1988); Hans Blumenberg, *The Genesis of the Copernican World*, trans. R. M. Wallace (Cambridge, Mass., 1987). See also Brian Vicars, "Francis Bacon and the Progress of Knowledge," *Journal of the History of Ideas* 53 (1992), 495–517. Interest in "fact" as a philosophical topic developed with Mill, Peirce, Bertrand Russell, F. H. Bradley, and Wittgenstein. See Kenneth Russell Olson, *An Essay on Facts* (Stanford, 1987).
4. It was one of the common ways Bodin and others distinguished civil and natural history.
5. See Dear, *Discipline and Experience*. See also Margaret Cook, "Divine Artificer, Corpuscular Mechanism, and Chemical Experiment: Robert Boyle's Experimental Philosophy of Nature" (paper delivered Nov. 11, 1997, at History of Science Society meeting, San Diego). Bacon's experimentally based natural philosophy also rejected the distinction between artificial and inartificial proofs.
6. See Paul Kocher, "Francis Bacon on the Science of Jurisprudence," *Journal of the History of Ideas* 18 (1957), 3–26; Harvey Wheeler, "The Invention of Modern Empiricism: Juridical Foundations of Francis Bacon's Philosophy of Science," *Law Library Journal* 76 (1983), 78–

120; Harvey Wheeler, "Science out of Law: Francis Bacon's Invention of Scientific Empiricism," *Toward a Humanistic Science of Politics: Essays in Honor of F. D. Wormuth*, ed. F. D. Nelson and R. L. Sklar (London, 1983), pp. 101–143; Kenneth Cardwell, "Inquisitio Rerum Ipsarum: Francis Bacon and the Interrogation of Nature" (Ph.D. dissertation, University of California, 1986); Kenneth Cardwell, "Francis Bacon, Inquisitor," in *Francis Bacon's Legacy of Texts*, ed. William A. Sessions (New York, 1990), pp. 269–289; Rose-Mary Sargent, "Scientific Experiment and Legal Expertise: The Way of Experience in the Seventeenth Century," *Studies in the History and Philosophy of Science* 20 (1989), 19–45; Mark Neustadt, "The Making of the Instauration: Science, Politics, and Law in the Career of Francis Bacon" (Ph.D. dissertation, Johns Hopkins University, 1987); Julian Martin, *Francis Bacon, the State, and the Reform of Natural Philosophy* (Cambridge, 1992); Daniel Coquillette, *Francis Bacon* (Stanford, 1992).

7. Francis Bacon, "De augmentis," in *The Works of Francis Bacon*, ed. James Spedding, Robert Leslie Ellis, and Douglas Denon Heath, 14 vols. (London, 1857–74), IV, 193, 292.

8. Bacon, "Novum Organon," book I, aphorism xcviii, *Works*, IV, 94.

9. Bacon, "Great Instauration," *Works*, IV, 19.

10. William Ashworth, "Natural History and the Emblematic World View," *Reappraisals of the Scientific Revolution*, ed. David Lindberg and Robert Westman (Cambridge, 1990), pp. 303–332. See also Michel Foucault, *The Order of Things: An Archeology of the Human Sciences* [1966] (New York, 1973).

11. See Joseph Levine, "Natural History and the History of the Scientific Revolution," *Clio* 13 (1983), 57–73; Alice Stroup, *A Company of Scientists* (Berkeley, 1990); Harold Cook, "The Cutting Edge of a Revolution? Medicine and Natural History near the Shores of the North Sea," in *Renaissance and Revolution: Humanists, Scholars, Craftsmen, and Natural Philosophers in Early Modern Europe*, ed. J. V. Field and Frank James (Cambridge, 1993), pp. 45–61; Nicholas Jardine, J. A. Secord, and E. C. Spary, *Cultures of Natural History* (Cambridge, 1996).

12. Bacon, "Preparative," aphorism ix, *Works*, IV, 261; "Parasceve" (Latin), *Works*, I, 402. See also "Parasceve," *Works*, IV, 252, 254; Paula Findlen, "Francis Bacon and the Reform of Natural History in the Seventeenth Century," in *History and the Disciplines: The Reclassification of Knowledge in Early Modern Europe*, ed. Donald R. Kelley (Rochester, N.Y., 1997), pp. 239–260.

13. Bacon, "Great Instauration," *Works*, IV, 26. Nature was to be interrogated. Bacon, "Preparative towards a Natural and Experimental History," *Works*, IV, 263.

14. Bacon, "Great Instauration," *Works*, IV, 32. See also "Novum Organon," *Works*, IV, 26, 30. Bacon, however, does not use "fact" consistently. "For questions are at our command, though facts are not." *Works*, V, 135. This translation is Cardwell's: "Bacon, Inquisitor," p. 280.

15. See Michael Witmore, "Culture of Accidents: Unexpected Knowledges in Early Modern England" (Ph.D. dissertation, University of California, Berkeley, 1997); Katherine Park and Lorraine Daston, "Unnatural Conceptions: The Study of Monsters in Sixteenth- and Seventeenth-Century France and England," *Past and Present* 92 (1981), 20–54.

16. Bacon, "Parasceve," aphorism viii, *Works*, IV, 260. Traditional natural history was "very different from that kind of history which I have in view." "Advancement of Learning," *Works*, IV, 299. See also "Parasceve," *Works*, IV, 252, 254.

17. See "Great Instauration," *Works*, IV, 12, 19, 32; "Novum Organon," book I, aphorism cxii, *Works*, IV, 102; aphorism cxxiv, *Works*, IV, 110. See also I, 203, 218; IV, 123. In the latter he used *de facto naturae*. See *Works*, I, 210. He also referred to the "inquisition of the fact itself" [*inquisitio facti ipsius*], *Works*, IV, 123; I, 232. See also "Preparative," aphorism ix, *Works*, IV, 261. In new and particularly subtle experiments it was necessary to show how the experiment was conducted so as to allow others to determine "whether the information obtained . . . be trustworthy or fallacious." *Works*, IV, 161.

18. "Great Instauration," *Works*, IV, 291. See also "Parasceve," *Works*, IV, 252.

19. Nature was to be interrogated, vexed, coerced, and manipulated in various ways to yield information. For Bacon's use of "inquisitio," see Cardwell, "Bacon, Inquisitor."

20. For "transmutation histories" providing narratives of matter of fact replete with witnesses and designation of exact times and places, see Laurence Principe, *The Aspiring Adept: Robert Boyle and the Alchemical Quest* (Princeton, 1998).

21. Thomas Hobbes, *Leviathan*, ed. M. Oakeshott (New York, 1962), p. 69.
22. Ibid., p. 45. "And whereas sense and memory are but knowledge of fact, which a thing past and irrevocable; Science is the knowledge of consequences, and dependence of one fact upon another" (p. 45). "Regular effects" might be a storehouse for prudence, which was "nothing but to conjecture from experience." Thomas Hobbes, *The Elements of Law*, in *English Works*, 11 vols., ed. William Molesworth (1839–45; reprint Aalen, Germany, 1962), IV, 16, 18.
23. Robert Hooke suggested that hypotheses might be "confirm'd by Fact or Effect." Hooke, *Posthumous Works*, ed. Richard Waller (London, 1705), p. 536.
24. William Harvey, *Disputations Touching the Generation of Animals* (Oxford, 1981), trans. Gweneth Whitteridge. Harvey's methods, however, were not those of the natural historian.
25. John Henry, "The Scientific Revolution in England," in *The Scientific Revolution in National Context*, ed. Roy Porter and Mikulas Teich (Cambridge, 1992), pp. 202–203; J. A. Bennett, "The Magnetical Philosophy," *Journal of the History of Astronomy* 12 (1981), 165–177.
26. John Aubrey, *Brief Lives*, ed. O. L. Dick (1949; reprint Ann Arbor, Mich., 1957), p. 320. *Philosophical Transactions* IV (1669), Dedicatory Letter to Seth Ward. Daniel Garber contrasts Baconian and Restoration Royal Society "facts," suggesting that the former were individual and the latter social. Garber, "Experiment." For the Hartlib circle, see Charles Webster, *The Great Instauration* (London, 1975). For Oxford, see Barbara J. Shapiro, *John Wilkins: An Intellectual Biography* (Berkeley, 1968), pp. 118–147; Shapiro, "Science and the Universities in Seventeenth-Century England," *Journal of British Studies* 10 (1971), 47–82; Margaret Purver, *The Royal Society: Concept and Creation* (Cambridge, Mass., 1967); Robert G. Frank, *Harvey and the Oxford Physiologists* (Berkeley, 1980).
27. Thomas Sprat, *The History of the Royal Society*, ed. Jackson Cope and H. W. Jones (St. Louis, 1958), pp. 70, 83, 99, 100. By the 1670s there were serious attendance problems. If members might take issue with some of Sprat's statements, there is no indication that he misrepresented Society views on the centrality of "matters of fact."
28. See Peter Dear, "Totius in Verba: Rhetoric and Authority in the Early Royal Society," *Isis* 76 (1985), 145–161.
29. Joseph Glanvill, *A Prefactory Answer to Mr. Henry Stubbe* (London, 1671), pp. 143–144; Glanvill, *Scepsis Scientifica* (London, 1665), p. 118; Glanvill, *Essays on Several Important Subjects in Philosophy and Religion* (London, 1676), essay II, pp. 46, 49–50.
30. Glanvill, *Essays*, essay VI, pp. 48–49, 56; essay I, p. 15. See also Glanvill, *Scepsis Scientifica*, Address to the Royal Society.
31. Henry Oldenburg, *Correspondence*, ed. and trans. A. R. Hall and M. B. Hall, 13 vols. (Madison, Wis., 1965–86), VIII, 538; VII, 260; III, 525. See also II, 14; XIII, 397; *Philosophical Transactions* I (1665–66), 65. See also pp. 130, 150.
32. Oldenburg, *Correspondence*, II, 401. See also II, 8–9, 384; M. B. Hall, "Science in the Early Royal Society," in *The Emergence of Science in Western Europe*, ed. Maurice Crosland (New York, 1976), pp. 57–78; John Henry, "The Origins of Modern Science: Henry Oldenburg's Contribution," *British Journal of the History of Science* 21 (1988), 103–110.
33. See Henry, "Scientific Revolution in England," pp. 178–209; K. Theodore Hoppen, "The Nature of the Early Royal Society," part 2, *British Journal for the History of Science* 9 (1976), 243–273; Michael Hunter, *Establishing the New Science* (Woodbridge, Suffolk, 1989), pp. 45–71; Oldenburg, *Correspondence*, V, 263.
34. Robert Hooke, *Lectures and Collections* (London, 1678), pp. 22–24. See also Ewen A. Whitaker, "Selenography in the Seventeenth Century," *History of Astronomy* 2, 119–143.
35. Quoted in David R. Oldroyd, "Some Writings of Robert Hooke on Procedures for the Prosecution of Scientific Inquiry, Including His 'Lectures of Things Requisite to a Ntral History,'" *Notes and Records of the Royal Society* 41 (1987), 146–47, 152, 157.
36. Quoted in ibid., pp. 152, 157.
37. R. T. Gunther, *Early Science in Oxford*, 15 vols. (Oxford, 1920–45), VI, 112.
38. Oldenburg, *Correspondence*, II, 383.
39. Humphrey Ridley, *Anatomy of the Brain* (London, 1695), preface; Peter Wyche, trans., *A*

Short Relation of the River Nile (London, 1669), preface; Robert Hooke, "Cometa," in *Lectiones Cutlerianae* (London, 1678), p. 34; *An Attempt to Prove the Motion of the Earth from Observation* (London, 1674), preface; *Philosophical Transactions* 1 (1665–66), 65; Oldenburg, *Correspondence*, II, 383, 384; John Ray, *The Wisdom of God* (London, 1692), preface. See also pp. 49, 126; Francis Willughby, *The Ornithology* (London, 1678), preface; John Evelyn, *Sylva* (London, 1664). For Lister, see Oldenburg, *Correspondence*, VII, 342. See also VII, 437, 462, 492; VIII, 318. For Wallis, see ibid., IX, 307. For Newton, see Stephen Rigaud, *Correspondence of Scientific Men of the Seventeenth Century*, 2 vols. (Oxford, 1841), II, 386.

40. John Woodward, *An Essay toward a Natural History of the Earth* (London, 1695); Hans Sloane, *A Voyage to the Islands Madera, Barbadoes, . . . with the Natural History*, 2 vols. (London, 1701), I, preface. Sloane used "phenomenon" synonymously with "Matter of Fact." Arthur MacGregor, *Sir Hans Sloane* (London, 1994), p. 14.

41. Oldenburg, *Correspondence*, III, 162. Sprat, in emphasizing the Royal Society's "submissive way of Registring nothing, but Histories, and Relations," also noted that "they have left room for others, . . . to change, to augment, to approve, to contradict them." *History of the Royal Society*, p. 116.

42. Shapin and Schaffer, *Leviathan and the Air Pump*; Marie Boas Hall, *Robert Boyle and Seventeenth-Century Chemistry* (Cambridge, 1958); James Jacob, *Robert Boyle and the English Revolution* (New York, 1977); Frederick O. Toole, "Robert Boyle's Concept of Science and Nature" (unpublished paper); Rose-Mary Sargent, *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment* (Chicago, 1995); Jan W. Wojcik, *Robert Boyle and the Limits of Reason* (Cambridge, 1997); Michael Hunter, ed., *Robert Boyle Revisited* (Cambridge, 1994); Margaret Osler, "The Intellectual Sources of Robert Boyle's Philosophy of Nature: Gassendi's Voluntarism and Boyle's Physico-Theological Project," in *Philosophy, Science, and Religion in England, 1640–1700*, ed. Richard Kroll, Richard Ashcraft, and Perez Zagorin, (Cambridge, 1992); Lawrence Principe, *Aspiring Adept: Robert Boyle and the Alchemical Quest* (Princeton, 1998).

43. But see Garber, "Experiment."

44. Robert Boyle, *General Heads for the Natural History of a Country, Great or Small Drawn Out for the Use of Travellers and Navigators* (London, 1692), p. 1.

45. Robert Boyle, *New Experiments Touching the Spring of Air* (London, 1662), preface; Robert Boyle, *The Christian Virtuoso* (London, 1690), p. 52; Robert Boyle, *The Works of the Honourable Robert Boyle*, ed. Thomas Birch, 6 vols. (London, 1772), II, 742, 744; I, 34. See Robert Kargon, "The Testimony of Nature: Boyle, Hooke, and Experimental Philosophy," *Albion* 3 (1971), 72–81.

46. Boyle, *Works*, VI, 524, 525; Boyle, *Christian Virtuoso*, pp. 57–58.

47. See Shapin, *Social History of Truth*. For a critique, see Sargent, "Scientific Experiment and Legal Expertise."

48. Boyle, "Experimental and Observationes Physicae," *Works*, V, 569; Boyle, "Certain Physiological Essays," *Works*, I, 313–314. See also Oldenburg, *Correspondence*, II, 177.

49. Robert Plot, *The Natural History of Oxfordshire*, 2d ed. (Oxford, 1705), To the Reader; Royal Society, Original Letters, I, fol. 177; Oldenburg, *Correspondence*, VII, 23–28; William Derham, *Philosophical Letters* (London, 1718), p. 175.

50. Thomas Birch, *The History of the Royal Society*, 4 vols. (London, 1760), I, 32, 33; Robert Hooke, *Micrographia* (London, 1665). [Matthew Hale], *Observations Touching the Principles of Natural Motions* (London, 1677), Preface to the Reader. Hale thought Bacon and his followers distinguished their approach too sharply from that of Aristotle. *Observations*, p. 105.

51. Sprat, *History of the Royal Society*, p. 215. Many reports, however, were incapable of experimental proof.

52. Henry Power, *Experimental Philosophy . . . With some Deductions, and Probable Hypotheses raised from them* (London, 1664), p. 58.

53. Richard Lower, *Justification of the Discourse on Fevers by Thomas Willis* [1665] (Oxford, 1983), p. 215. See also p. 218; *A Brief Account of Mr. Valentine Greatrakes and Divers of the Strange Cures* (London, 1666), pp. 37, 40.

54. Oldenburg approached diplomats Sir John Finch, Sir Paul Rycaut, and Sir Robert Southwell to contribute to their "philosophical correspondence." The Society wished "all sorts of Intelligent and Publick minded men in all parts of the world to contribute." Diplomat members of the Royal Society, often viewed as inactive because rarely present, thus contributed substantially to the Society's endeavors. Sir Joseph Williamson, secretary of state, a member since 1663, served as president from 1677 to 1680. See Oldenburg, *Correspondence*, III, 525; VII, 8–9; IX, 338; X, 483; Royal Society Letterbook I, Original Letters, fols. 299, 303, 336.
55. Oldenburg, *Correspondence*, III, 525; VII, 8–9; Margaret Deacon, *Scientists and the Sea, 1650–1900* (New York, 1971), p. 84; Hooke quoted in David R. Oldroyd, "Geological Controversy in the Seventeenth Century: 'Hooke vs Wallis' and Its Aftermath," in *Robert Hooke: New Studies*, ed. Michael Hunter and Simon Schaffer (Woodbridge, Suffolk, 1989), pp. 223–224; Edmund Halley, *An Historical Account of the Trade-Winds and Monsoon, observable in the Tropics*, in William Derham, *Miscellanea Curiosa*, 2 vols., 3d ed. (London, 1726), I, 61.
56. Sprat, *History of the Royal Society*, p. 200; Henry Stubbe, *Legends No Histories* (London, 1670), pp. 21, 120. For emphasis on the positive role of merchants, see Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago, 1998).
57. Boyle's interest in projects connected with the sea led him to rely on seamen of varying status. Deacon, *Scientists and the Sea*, pp. 119, 112, 124, 126, 127, 134.
58. Sprat, *History of the Royal Society*, pp. 432, 72. Sprat overestimated the contributions that merchants and husbandmen would make. He admitted many reports lacked "sufficient confirmation to raise Theories, or Histories on them." Ibid., p. 195.
59. Ibid., p. 257; Oldroyd, "Some Writings of Robert Hooke," pp. 157–158; Royal Society, Original Letters, II, fol. 281. See also W. E. Houghton, "The History of Trades: Its Relation to Seventeenth-Century Scientific Thought," in *Roots of Scientific Thought: A Cultural Perspective*, ed. P. P. Wiener and A. Noland (New York, 1957), pp. 354–381; K. H. Ochs, "The Royal Society of London's History of Trade Programme," *Notes and Records of the Royal Society* 39 (1985), 129–158.
60. Oldenburg, *Correspondence*, IV, 337; Oldroyd, "Some Writings of Robert Hooke," pp. 165–167; John Aubrey, *The Natural History and Antiquities of the County of Surrey* (London, 1718–19), p. 410.
61. Shapin and Schaffer, *Leviathan and the Air Pump*; Shapin, *Social History of Truth*; Sargent, *Diffident Naturalist*.
62. Oldenburg, *Correspondence*, X, 198. He favored using "Register-books of Merchants, English and Dutch, to observe" natural rarities. Ibid.
63. Shapin, *Social History of Truth*, p. 293, quoting from Boyle, *Certain Physiological Essays*.
64. Boyle, "Experimenta et observationes physicae," *Works*, V, 608. See also *Works*, V, 605, 607.
65. Boyle, *Works*, III, 396, 442–445. For earlier connections between craftsmen and gentleman investigators, see Leslie Cormack, *Charting an Empire: Geography at the English Universities, 1580–1620* (Chicago, 1997), p. 51.
66. Boyle, "Certain Physiological Essays," *Works*, I, 306, 314. Observation required "either skill or curiosity, or both in the Observer." Boyle, "The Usefulness of Experimental Philosophy," *Works*, III, 472.
67. R. S. Westfall, "Unpublished Boyle Papers Relating to Scientific Method," *Annals of Science* 12 (1956), 71, 73. See also Boyle, *Some Considerations about the Reconcileableness of Reason and Religion* (London, 1675), p. 61.
68. Boyle, *Christian Virtuoso*, p. 72.
69. Quoted in Oldroyd, "Some Writings of Robert Hooke," p. 152. Shapin, *Social History of Truth*, pp. 363, 365, 376, 383, 392; Shapin, "Who Was Robert Hooke?" in *Robert Hooke: New Studies*, ed. Michael Hunter and Simon Schaffer (Woodbridge, Suffolk, 1989), pp. 253–286. But see Ellen Tan Drake, *Restless Genius: Robert Hooke and His Earthly Thoughts* (New York, 1966); *The Diary of Robert Hooke, 1672–1680*, ed. Henry Robinson and Walter Adams (London, 1935).
70. For Boyle, "faithfulness in truly delivering what he knows" was one of two essential qual-

ities of a witness. Oldenburg, *Correspondence*, I, 434; VII, 8–9; VIII, 538; Boyle, *Works*, I, 314; Boyle, *Christian Virtuoso*, pp. 52–72.

71. Boyle, however, questioned More's competence and implied that More was subject to "hallucinations." Shapin, *Social History of Truth*, pp. 297–298. See also "A Calculation of the Certainty of Humane Testimony," *Philosophical Transactions* XXXI (Oct. 1699), 359–360.

72. Royal Society, Original Letters, III, fol. 14.

73. See *The Four Footed Beast* (London, 1668), Dedicatory Letter; Derham, *Miscellanea Curiosa*, I, 61. Oldenburg, in connection with a strange case of triplets, wrote that though the report came from "an excellent Oculist," the Society wished the "double attestation" of the two physicians present. *Correspondence*, I, 277, 280.

74. Robert Hooke, *Micrographia* (London, 1665), preface; *Philosophical Experiments and Observations*, ed. William Derham (London, 1726), pp. 27, 28; Oldroyd, "Some Writings of Robert Hooke," p. 158. Leeuwenhoek in 1677 sent testimonials from eight witnesses to support his observations. Edward G. Ruestow, *The Microscope in the Dutch Republic: The Shaping of Discovery* (Cambridge, 1996), pp. 154–155.

75. Robert Boyle, "Some Considerations about the Reconcileableness of Reason and Religion," *Works*, IV, 182.

76. Sir Matthew Hale, *The Primitive Origination of Mankind* (London, 1678), p. 128. An anonymous article in the *Philosophical Transactions* attempted to calculate how increasing numbers of concurrent reports might approximate moral certainty. A single witness might be certain to half a full certainty; the second with the first yielded three-fourths; the third, seven-eighths. By the tenth it would reach 1023/1024 of certainty, and the twentieth, over two million to one. "Calculation of the Certainty of Humane Testimony." XXXI (1669), 359–360.

77. Michael Hunter and Paul B. Wood, "Towards Solomon's House: Rival Strategies for Reforming the Early Royal Society," *History of Science* 24 (1986), 79.

78. Harvey Wheeler and Rose-Mary Sargent suggest that scientific principles and legal principles were developed by similar procedures. See Wheeler, "Science out of Law"; Sargent, "Scientific Experiment and Legal Expertise"; Sargent, *Diffident Naturalist*, pp. 42–61. It is difficult to see how Coke's distinction between ordinary reason and the reason of the law, accessible only to judges and lawyers of long experience, can be equated to Boyle's use of the term "reason," which rejects arcane learning. Jurists distinguished between the unchanging laws of nature and the mutable laws of man, recognizing that different nations operated according to different legal principles. Common and civil laws thus might treat the same set of facts differently. English judges would not, as Sargent suggests, have recognized their activity as "interpreting facts." Nor would naturalists have thought that principles regulating natural phenomena would vary from place to place and time to time.

79. Oldenburg, *Correspondence*, III, 163.

80. Christopher Merret, *Self-Conviction: Or an Enumeration of the Absurdities, . . . [and] Falsities in Matters of Fact* (London, 1670).

81. Differences of opinion with respect to hypotheses would be far less difficult to deal with because they were, by definition, uncertain. See Chapter 6.

82. Hevelius, a wealthy magistrate, was "Europe's premier telescopic observer." Albert Van Helden, "Telescopes and Authority from Galileo to Cassini," *Osiris*, 2d ser., 9 (1994), 19. Both Hevelius and Auzout were members.

83. Oldenburg, *Correspondence*, II, 653.

84. *Philosophical Transactions* IX (Feb. 1666), 150–151.

85. Oldenburg, *Correspondence*, III, 6.

86. Oldenburg, *Correspondence*, III, 6, 24, 30, 170–171, 219. Gilles De Launay also referred to the Royal Society as a "tribunal." Ibid., IV, 218.

87. Oldenburg, *Correspondence*, III, 219, 324; Royal Society, Original Letters, II, fol. 376. *Philosophical Transactions* I (1665–66), 151; Oldenburg, *Correspondence*, II, 653. For a somewhat different interpretation, see Shapin, *Social History of Truth*, pp. 286–289. Disputes over astronomical "facts" were not unusual. Eugene Fairfield MacPike, *Hevelius, Flamsteed, and*

Halley: Three Contemporary Astronomers and Their Mutual Relations (London, 1937), pp. 81–102; Van Helden, "Telescopes and Authority," pp. 9–29.

88. Oldenburg, *Correspondence*, VII, 284. See also VII, 286.

89. Extreme cold seemed incredible to those living in the Congo. East Indian travelers were disbelieved when they claimed that a "fluid body of water" could, in a few hours, become a solid and compact body, such as ice. Quoted in Shapin, *Social History of Truth*; Boyle, "New Experiments and Observations touching Cold," *Works*, II, 477, 573.

90. Galileo contrasts the "eyes of an idiot" with those of a "careful and practiced anatomist or philosopher." "Letter to the Grand Duchess Christina," in *Discoveries and Opinions of Galileo*, trans. Stillman Drake (New York, 1957), p. 196. For Descartes, inventions that increased the power of the senses were "undoubtedly among the most useful there can be." *The Philosophical Writings of Descartes*, trans. and ed. J. Cottingham et al. (Cambridge, 1985), p. 152. See also Albert Van Helden, "The Birth of the Modern Scientific Instrument, 1550–1700," in *The Uses of Science in the Age of Newton*, ed. John J. Burke (Berkeley, 1983), pp. 49–84; J. A. Bennett, "The Mechanics' Philosophy and the Mechanical Philosophy," *History of Science* 24 (1986), 1–28.

91. Experimentalists without sense-enhancing instruments were no more than "empty conjecturalists." Power, *Experimental Philosophy*, preface. See also Oldroyd, "Some Writings of Robert Hooke," pp. 145–167; Sprat, *History of the Royal Society*, pp. 94, 246–252, 384–385; William Gibson, "The Medical Interests of Christopher Wren," in *Some Aspects of Seventeenth-Century Medicine and Science* (Los Angeles, 1969), p. 8.

92. Hooke, *Micrographia*, preface. Instruments immensely extended Hooke's "empirical horizon." See Catherine Wilson, *The Invisible World: Early Modern Philosophy and the Invention of the Microscope* (Princeton, 1995). Nehemiah Grew also spoke of revealing "a new world." *Anatomy of Plants* (London, 1682), preface. Boyle wrote, "If we were sharp-sighted enough, or had such perfect microscopes, . . . our promoted senses might discern" the minute differences that explain colors we see in visible objects. Boyle, *Works*, V, 680. Microscopes would provide sight of what the "Atomical and Corpuscularian Philosophers durst but imagine." Power, *Experimental Philosophy*, preface. See also Sprat, *History of the Royal Society*, pp. 384–385; Joseph Glanvill, *Plus Ultra* (London, 1668), p. 57; Ruestow, *Microscope in the Dutch Republic*, pp. 15, 17–18, 24.

93. Wilson, *Invisible World*, pp. 57, 68, 100. See also ibid., pp. 140–175.

94. It was recognized, however, that instruments had their problems. Leewenhoek's observations were doubted in part because his critics were unable to obtain similar instruments and because Royal Society members did not see what Leeuwenhoek claimed to have seen, even though witnesses vouched for him. Microscopists were aware of the difficulties in interpreting what had been observed. Enthusiasm abated after 1690. See Wilson, *Invisible World*, pp. 100–101, 215–256; Oldenburg, *Correspondence*, II, 653. Astronomical disputes sometimes turned on the issue of instrument quality. See Robert Hooke, *Animadversions on the First Part of the Machina Coelestis of . . . Johannes Hevelius* (London, 1674).

95. Hale, *Primitive Origination of Mankind*, p. 130.

96. Sprat, *History of the Royal Society*, pp. 214–215, 243–245.

97. *Philosophical Transactions* I (1665–66), 193; Boyle, *Works*, III, 614–615, 624–628.

98. John Woodward, *The Natural History of the Earth* (London, 1726), p. 158.

99. Quoted in Michael Hunter, *Science and the Shape of Orthodoxy* (Woodbridge, Suffolk, 1995), p. 182.

100. Robert Hooke, "A Discourse of Earthquakes," in *The Posthumous Works of Robert Hooke*, ed. Richard Waller (London, 1705), p. 335. See also p. 321. Hooke wrote, "I conceive it Lawful and Philosophical to Jurare in Verba, when Nature speakes or dictates." Quoted in Drake, *Restless Genius*, p. 324.

101. Boyle, "An Hydrostatical Discourse," *Works*, III, 626.

102. William Derham, *Philosophical Letters* (London, 1718), p. 62.

103. *Martin Lister's English Spiders* (1678), trans. M. Davies and B. Harley (Colchester, 1992), p. 48.

104. Moses Pitt's *English Atlas* exhibited "a true Representation of the Universe . . . there being nothing more conducive to the assistance of the understanding and memory than a plain simple, clear and uncompounded representation of the Object of the Sense." Preface. He suggested "pictures of . . . Observables" could show what might "not otherwise be so fully and sensibly expressed by Verbal Description." Robert Hooke, *Of the True Method of Building a Solid Philosophy, or of a Philosophical Algebra*, in *Posthumous Works*, p. 64. See also John T. Harwood, "Rhetoric and Graphics in *Micrographia*," in *Robert Hooke: New Studies*, ed. Michael Hunter and Simon Schaffer (Woodbridge, Suffolk, 1989), pp. 119–147; Michael Aaron Dennis, "Graphic Understanding: Instruments and Interpretation in Robert Hooke's *Micrographia*," *Science in Context* 3 (1989), 309–364. Hooke's microscopic illustrations were composites of repeated observations, not records of particular observations. *Micrographia*, Preface. See also Wilson, *Invisible World*, pp. 86–88. For Hooke's illustrative sketches, see Oldroyd, "Some Writings of Robert Hooke," pp. 147, 155–156. Hooke had been apprenticed to a portrait painter and considered a career as a painter. Drake, *Restless Genius*, p. 11.

Evelyn provided engravings of natural objects he had seen himself or for which he had "unquestionable testimony." *Sylva* (London, 1664), preface. For Evelyn, a collection of prints was "a kind of Encyclopedia of all intelligibles, and memorable things that either are, or have been *in rerum Natura*." Richard Nicolas, *The Diaries of Robert Hooke, the Leonardo of London, 1635–1703* (Lewes, Sussex, 1994), p. 141. See also Willughby, *Ornithology*; Nehemiah Grew, *Musaeum Regalis Societatis* (London, 1681); Eleazar Albin, *A Natural History of English Insects* (London, 1724). John Ray noted that many "looked upon a history of plants without figures as a book of geography without maps." Ray, *Correspondence*, 1848, p. 155, quoted in Gill Saunders, *Picturing Plants* (Berkeley, 1995), p. 7. See also Robert W. Unwin, "A Provincial Man of Science at Work: Martin Lister, F.R.S., and His Illustrators, 1670–1683," *Notes and Records of the Royal Society* 49 (1995), 202–230.

For Dutch painters and natural history, see Ruestow, *Microscope in the Dutch Republic*, pp. 48–56, 68–77, 134–136. See also Mary G. Winkler and Albert Van Helden, "Representing the Heavens: Galileo and Visual Astronomy," *Isis* 83 (1991), 195–217; Winkler and Van Helden, "Johannes Hevelius and the Visual Language of Astronomy," in *Renaissance and Revolution: Humanists, Scholars, Craftsmen, and Natural Philosophers in Early Modern Europe*, ed. J. V. Fields and Frank James (Cambridge, 1993), pp. 97–116.

105. Steven Shapin, "Pump and Circumstance: Robert Boyle's Literary Technology," *Social Studies of Science* 20 (1982), 481–520. Peter Dear suggests that circumstantial detail was provided to enhance the sense of actuality. Dear, "Narratives, Anecdotes, and Experiments: Turning Experience into Science in the Seventeenth Century," in *The Literary Structure of Scientific Argument*, ed. Dear (Philadelphia, 1991), pp. 135–163.

106. Hooke, *Posthumous Works*, p. 63. See also Hooke, *Philosophical Experiments and Observations*, pp. 26–28; Boyle, "Certain Physiological Essays," *Works*, I, 314.

107. Sprat, *History of the Royal Society*, p. 73.

108. Ibid. See also p. 7. Evelyn referred to the Society as "acute and learned Judges." John Evelyn, *A Philosophical Discourse of Earth* (London, 1676), p. 8.

109. Wilkins related judgment to evidence. *Essay Towards a Real Character and a Philosophical Language* (London, 1668), p. 202.

110. See Oldenburg, *Correspondence*, IX, 658; II, 27; Hooke, *Micrographia*, preface. For Newton, see Rigaud, *Correspondence of Scientific Men*, II, 317. See also Peter Dear, "From Truth to Disinterestedness in the Seventeenth Century," *Social Studies of Science* 22 (1992), 619–632.

111. Royal Society, Boyle Letters, I, 108r, 131r; Boyle, "New Experiments," *Works*, II, 626; Oldenburg, *Correspondence*, III, 342; Woodward, *Natural History of the Earth*, preface.

112. Locke's views and role are discussed in Chapter 8.

113. See W. B. Brockliss, "The Scientific Revolution in France," in *The Scientific Revolution in National Context*, ed. Roy Porter and Mikulas Teich (Cambridge, 1992), pp. 55–89; Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803* (Berkeley, 1971); Robin Briggs, "The Académie Royale des Sciences and the Pursuit of Utility," *Past and Present* 131 (1991), 38–87; Dear, *Discipline and Experience*.

114. Rabelais, however, used the expression "des faictz de nature." Cited in Edwin M. Duval, *The Design of Rabelais's Pantagruel* (New Haven, 1991), p. 49. "Faict" was sometimes used in the medieval era in referring to monsters (I owe this information to Michael Witmore). See also Stroup, *Company of Scientists*; Lorraine Daston, "Strange Facts, Plain Facts, and the Texture of Scientific Experience in the Enlightenment," in *Proof and Persuasion: Essays on Authority, Objectivity, and Evidence*, ed. S. Marchand and E. Lunbeck (Brepols, Belgium, 1996), pp. 42–59; Christian Licoppe, *Le formation de la pratique scientifique: Le discourse de l'expérience en France et en Angleterre (1630–1820)* (Paris, 1996).

115. Christian Huygens felt the Académie des Sciences should concentrate on a "natural history . . . according to the plan of Verulamus." R. Hooykaas, "The Rise of Modern Science: When and Why?" *British Journal of the History of Science* 20 (1987), 453–473. Auzout in 1666 used "fait" in connection with his observations of comets. Oldenburg, *Correspondence*, III, 294; Stroup, *Company of Scientists*, pp. 66–67, 69, 71, 73. See also D. Dodart, *Mémoires pour servir à l'histoire des plantes* (1676); Rio C. Howard, "Guy de la Brosse and the Jardin des plantes in Paris," in *The Analytic Spirit*, ed. Harry Woolf (Ithaca, 1981), pp. 195–224; Harold J. Cook, "Physicians and Natural History," in *Cultures of Natural History*, ed. Nicolas Jardine, J. A. Secord, and E. C. Spary (Cambridge, 1996), p. 102.

116. *Mémoires pour servir à l'histoire naturelle des animaux* (Paris, 1671), preface. A translation was ordered by the Royal Society in 1688. I quote from the translation unless otherwise indicated. Perrault's "Projet pour les expériences et observations anatomiques" employs two categories, fact (*de fait*) and law. The latter seems to refer to explanation. "Fait" covered witnesses of sight and touch, law, reasoning, and interpretation. Experiment involved both. Preface.

117. Perrault, *Mémoires*, preface. See also Kevin John Muhall, *Claude Perrault, 1613–1688, ou, la curiosité d'un classique* (Paris, 1988), pp. 44–45. For fact and hypothesis, see ibid.

118. Perrault, *Mémoires*, preface.

119. Ibid. For the rhetoric of proof in the Academy, see Licoppe, *La formation de la pratique scientifique*, pp. 52–87.

120. Sprat, *History of the Royal Society*, pp. 125–126, 253; Oldenburg, *Correspondence*, III, 140; IV, 153, 192. For Huygens's adoption of the first-person narrative for experiments, see Licoppe, *La formation de la pratique scientifique*, p. 61.

121. Bernard de Fontenelle, *Memoirs of the Royal Academy of Science*, preface, cited in Derham, *Miscellanea Curiosa*. See also Hahn, *Anatomy of a Scientific Institution*, pp. 26, 28, 32, 33. The collective review of facts and experiments was typical of the period 1667–92. It was replaced by collective adjudication of individual projects. Ibid., p. 28. Fontenelle's *Elogium of Sir Isaac Newton* (London, 1708) referred to Newton's experiments as "matters of fact" (p. 17).

The adoption of "fact" by French naturalists was not recognized in seventeenth-century dictionaries. See *Le dictionnaire de l'Académie Française*, 2 vols. (1694). By the mid-eighteenth century "fait" had become part of the vocabulary of both English and French natural investigators. The *Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts, et des Métiers* (1761) noted its uses in law, history, and natural philosophy (VI, 383). The entry discussed witnessing and precautions against passion and prejudice. Buffon wrote that both civil and natural history were founded "sur des faits." Quoted in Seifert, *Cognitio Historica*, p. 181n.

In France, too, the "discourse of fact" appears to have been associated with a relatively plain style. In 1699 the Académie des Sciences "declared that nature would appear there quite unadorned, not having thought fit to borrow from the gentlemen of the *Académie française* any of the finery and bedizenments they have in stock." Quoted in Paul Hazard, *The European Mind, 1680–1715*, trans. J. Lewis May (Cleveland, 1963), p. 310. See also Christian Licoppe, "The Crystallization of a New Narrative Form in Experimental Reports (1660–1690)," *Science in Context* 7 (1994), 205–244.

122. Daston, "Strange Facts, Plain Facts," pp. 42–59.

123. See David Goodman, "The Scientific Revolution in Spain and Portugal," in *The Scientific Revolution in National Context*, ed. Roy Porter and Mikulas Teich (Cambridge, 1992), pp. 178–210; David Goodman, "Iberian Science: Navigation, Empire, and Counter-Reformation," in *The Rise of Scientific Europe*, ed. David Goodman and Colin Russell (Kent, 1991), p. 125;

R. Hooykaas, *Humanists and the Voyages of Discovery in Sixteenth-Century Portuguese and Letters* (Amsterdam, 1979), pp. 14–15; Antonello Gerbi, *Nature in the New World*, trans. J. Moyle (Pittsburgh, 1985); Anthony Pagden, "Ius et Factum: Text and Experience in the Writings of Bartolomé de las Casas," in *New World Encounters*, ed. Stephen Greenblatt (Berkeley, 1991), pp. 91, 94; Paula Findlen, "Courting Nature," in *Cultures of Natural History*, ed. Nicolas Jardine, J. A. Secord, and E. C. Spary (Cambridge, 1996), pp. 57–74. See also Margaret Hodgen, *Early Anthropology in the Sixteenth and Seventeenth Centuries* (Philadelphia, 1964); Howard F. Cline, "The Relaciones Geográficas of the Spanish Indies, 1577–1586," *Hispanic American Historical Review* 44 (1964), 341–374; Anthony Pagden, *European Encounters with the New World* (New Haven, 1993), pp. 55, 57, 58, 60–61, 74–75, 82–83; José de Acosta, *The Naturall and Morall History of the Indies* (London, 1604); Daniel Banes, "The Portuguese Voyages and the Discovery and the Emergence of Modern Science," *Journal of the Washington Academy of Sciences* 28 (1988), 47–88. Like most European legal systems, that of Spain distinguished between fact (*hecho*) and law (*derecho*).

124. I wish to thank Justin Suran and Harold Cook for assistance with Dutch materials. The closest equivalents to "matter of fact" and "matter of law" appear to be "een feitelijke kwestie" and "een rechskwestie." Cook suggests that the term "werkelijk" was closer to Dutch use in natural history and medicine than "feit."

125. See Harold J. Cook, "The New Philosophy in the Low Countries," in *The Scientific Revolution in National Context*, ed. Roy Porter and Mikulas Teich (Cambridge, 1992), pp. 115–149; Cook, "Cutting Edge of a Revolution?" pp. 45–61; L. C. Palm, "Leeuwenhoek and Other Dutch Correspondents of the Royal Society," *Notes and Records of the Royal Society* 43 (1989), 191–207; Svetlana Alpers, *The Art of Describing: Dutch Art in the Seventeenth Century* (Chicago, 1983).

126. Oldenburg, *Correspondence*, III, 162; IX, 968, 658. See also Derham, *Miscellanea Curiosa*, I, 200.

127. Oldenburg, *Correspondence*, III, 162.

128. Peter Dear, however, suggests that all matters of fact were of moral certainty and that the phrase "probable matter of fact" was an oxymoron. "From Truth to Disinterestedness

Chapter 6: The Facts of Nature II

1. Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, 1985); Steven Shapin, *The Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, 1994). Mario Biagoli similarly suggests, "A claim would become a matter of fact only through the gentlemen acting like gentlemen around it." "Tacit Knowledge, Courtliness, and the Scientist's Body," in *Choreographing History*, ed. S. L. Foster (Bloomington, Ind., 1995), p. 75.

2. See Steven Shapin, "Who Was Robert Hooke?" in *Robert Hooke: New Studies*, ed. Michael Hunter and Simon Schaffer (Woodbridge, Suffolk, 1990), pp. 253–286; Stephen Pumphrey, "Ideas above His Station: A Social Study of Hooke's Curatorship of Experiments," *History of Science* 29 (1991), 1–37. For review symposia and Shapin's response, see *MetaScience* 6 (1994), 1–23. For the epistemological importance of merchants, see Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago, 1998).

3. It is thus unclear whether John Wilkins, one of founders of the Royal Society and the son of an Oxford goldsmith, would have been considered a gentlemen or, if so, whether he attained that status when he became a doctor of divinity, warden of Wadham College, or bishop of Chester. Could John Ray, the most praised natural historian of his generation but a dependent of gentleman Sir Francis Willughby, have been outside the range of credible witnessing? For the view that Boyle's conception of virtue rejected the traditional emphasis on noble and gentle status, see James R. Jacob, *Robert Boyle and the English Revolution: A Study in Social and Intellectual Change* (New York, 1977), p. 71.

4. See Shapin, "Who Was Robert Hooke?" But see also Ellen Tan Drake, *Restless Genius: Robert Hooke and His Earthly Thoughts* (New York, 1996).

5. Thomas Sprat, *History of the Royal Society*, ed. Jackson Cope and H. W. Jones (St. Louis,

1958), p. 67. Hooke occasionally met with the king. Robert Hooke, *The Diary of Robert Hooke, 1672–1680*, ed. Henry Robinson and Walter Adams (London, 1935), passim. Few members were tradesmen or artisans. Michael Hunter, *The Royal Society and Its Fellows, 1660–1700: The Morphology of an Early Scientific Institution* (Chalfont St. Giles, England, 1982).

6. See Barbara Shapiro, "The Universities and Science in Seventeenth-Century England," *Journal of British Studies* 10 (1971), 47–82. See also Mordecai Feingold, "What Facts Matter," *Isis* 87 (1996), 131–139.

7. Steven Shapin, "Pump and Circumstance: Robert Boyle's Literary Technology," *Social Studies of Science* 14 (1984), 481–521; Jan Golinski, "Robert Boyle: Skepticism and Authority in Seventeenth-Century Chemical Discourse," in *The Figural and the Literal: Problems of Language in the History of Science and Philosophy, 1630–1800*, ed. A. E. Benjamin, G. N. Cantor, and John R. R. Christie (Manchester, 1987), pp. 58–82.

8. Nigel Smith, *Literature and Revolution in England, 1640–1660* (New Haven, 1993), p. 57.

9. See also Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 79 (1986), 373–404. Though many experiments were performed before the assembled Royal Society, others took place in smaller, even private, yet legitimate venues such as Boyle's laboratory or the Interregnum lodgings of Petty and Wilkins. English legal experience exhibits some analogs. Although common law suits were tried publicly, trials often took place in a variety of semipublic, semiprivate venues when judges toured their circuits. The "courthouse" of modern times existed no more than the modern "laboratory." The judicial activities of quarter and especially petty sessions often were conducted in private locations. Felony suspects were frequently examined in justices' homes.

10. Sprat holds up Christopher Wren as the embodiment of the ideal naturalist.

11. See Michael Walzer, "Good Aristocrats/Bad Aristocrats: Thomas Hobbes and Early Modern Political Culture," in *The Presence of the Past*, ed. R. Bienvenue and M. Feingold (Amsterdam, 1991), pp. 41–51; Frank Whigham, *Ambition and Privilege: The Social Tropes of Elizabethan Courtesy Literature* (New York, 1984).

12. Humanist intellectuals self-consciously confronted the disparity between knowledge and power.

13. See Michael Hunter and Paul Wood, "Towards Solomon's House: Rival Strategies for Reforming the Early Royal Society," *History of Science* 24 (1996), 49–108.

14. Sprat, *History of the Royal Society*, p. 36.

15. John Wilkins, *The Principles and Duties of Natural Religion* (London, 1675), pp. 26–27.

16. See Ralph M. Blake, "Theories of Hypothesis among Renaissance Astronomers," in *Theories of Scientific Method: The Renaissance through the Nineteenth Centuries*, ed. Edward Madden (Seattle, 1960); Edward Grant, "Hypotheses in Late Medieval and Early Modern Science," *Daedalus* 91 (1962), 599–616; Larry Lauden, *Science and Hypothesis* (Dordrecht, 1981); Margaret Morrison, "Hypotheses and Certainty in Cartesian Science," in *An Intimate Relation: Studies in History and Philosophy of Science Presented to Robert E. Butts*, ed. J. R. Brown and J. Mittelstrass (Dordrecht, 1989); Desmond Clarke, *Descartes' Philosophy of Science* (University Park, Pa., 1982); Daniel Garber, *Descartes' Metaphysical Physics* (Chicago, 1992). Gassendi believed that all empirical knowledge is conjectural.

17. But see Peter Urback, *Francis Bacon's Philosophy of Science: An Account and a Reappraisal* (La Salle, Ill., 1987), pp. 34, 38 ff.; L. Jonathan Cohen, *The Probable and the Provable* (Oxford, 1977).

18. See Barbara J. Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983), pp. 44–61; Blake, "Theories of Hypothesis." "Doctrine" too was sometimes used interchangeably with "theory." Dictionary definitions of "conjecture" and "hypothesis" did not conform to virtuosi usage. "Hypothesis" was treated as a supposition or something conditional. "Theory" was characterized as the speculative part of any science and distinguished from practice. Occasionally, it was treated the same as "hypothesis." "Theorem" was also associated with mathematics. "Conjecture" was sometimes defined as "guess." See H. D., *The English Dictionary* (London, 1626); Edward Philips, *The New World of English Words* (London, 1658). (The 1671

and 1696 editions had assistance from leading antiquaries and virtuosi, e.g., Boyle, Wallis, Hooke, Ray, Flamsteed, Glisson, Sydenham, and Evelyn). See also Elisha Coles, *A Dictionary* (London, 1671); T. Blount, *Glossographia* (London, 1681); N. Bailey, *A Universal Etymological English Dictionary* (London, 1721); John Kersey, *Dictionarium Anglo-Britannicum* (London, 1708).

19. Sprat, *History of the Royal Society*. There is scholarly disagreement over the *History*'s aims and representativeness. Michael Hunter finds it more Baconian than most members would have accepted and suggests that Sprat's statements on hypothesis were unrepresentative. "The Early Royal Society and the Shape of Knowledge," in *The Shape of Knowledge from the Renaissance to the Enlightenment*, ed. D. R. Kelley and R. H. Popkin (Dordrecht, 1991), pp. 189–202. See also Michael Hunter, "Latitudinarianism and the 'Ideology' of the Early Royal Society: Thomas Sprat's *History of the Royal Society* (1667) Reconsidered," in *Establishing the New Science* (Woodbridge, Suffolk, 1989), pp. 199–216. P. B. Wood recognizes Wilkins's control of the shape and content of the *History* but views it as a "subtle misrepresentation and selective exposition." "Methodology and Apologetic: Thomas Sprat's *History of the Royal Society*," *British Journal for the History of Science* 13 (1980), 1–26. Margaret Purver views the *History* as an authoritative statement of the Society's Baconianism. See also Peter Dear, "Totius in verba: Rhetoric and Authority in the Early Royal Society," *Isis* 76 (1985), 145–161; H. Fisch and H. W. Jones, "Bacon's Influence on Sprat's History of the Royal Society," *Modern Language Quarterly* 12 (1951), 399–406. Some have inferred Society dissatisfaction from failure to reprint the *History* immediately. It seems more likely that the *History* served its immediate apologetic purpose and that its latitudinarianism no longer was politic after defeat of the 1667–68 comprehension proposals. Hooke referred to Sprat's "excellent History." *Lectiones Cutlerianae*, ed. R. T. Gunther (Oxford, 1931), p. 150.

20. Sprat, *History of the Royal Society*, pp. 255–257, 311–318.

21. Henry Oldenburg, *Correspondence*, ed. and trans. A. R. Hall and M. B. Hall, 13 vols. (Madison, Wis., 1965–86), VII, 260.

22. Sprat, *History of the Royal Society*, pp. 18, 28, 30, 32, 38–39.

23. Ibid., pp. 311–318. Wren had added to "the Theory of Dioptrics," contributed to the "Theory of Refraction, which exactly answer'd every Experiment," made observations on Saturn and "a Theory of that Planet, truly answering all Observations," and produced a "theory of the Moon's Libration, as far as his Observations could carry him." Ibid., p. 315.

24. Sprat, *History of the Royal Society*, p. 311; J. A. Bennett, "Hooke and Wren and the System of the World: Some Points toward an Historical Account," *British Journal for the History of Science* 8 (1975), 55. Sprat's characterization of some members' efforts as "theory" and others as "hypothesis" did not clarify the distinction between the two. His usage is rather odd given Wilkins's supervisory role. Wilkins's *Essay on a Real Character* placed "theorem" under the category "Rule" along with maxim, axiom, principle, and canon; "hypothesis" was placed in the category "supposition." John Wilkins, *Essay towards a Real Character and a Philosophical Language* (London, 1668), pp. 48, 49.

25. *Philosophical Transactions* XVI (1686), 001–2.

26. *Philosophical Transactions* II (1667), 105; Royal Society, Original letters, II, fols. 300, 314. Oldenburg highlighted the "faithfull history" of nature and art derived from careful observation and experiment, which eventually would raise a "body of natural philosophy, that may give a rational account of ye effects of nature, and enable men to inferr from confirmed cause and, effects, such deductions may conduce" to man's benefit. *Correspondence*, VII, 260.

27. Oldenburg, *Correspondence*, IX, 16–17, X, 109. William Derham refers to Newton's theory of the moon. *Miscellanea Curiosa*, 3d ed., 3 vols. (London, 1726), I, 279.

28. C. H. Weld, *A History of the Royal Society*, 2 vols. [1848] (New York, 1975), II, 526–527; M. B. Hall, "Science in the Early Royal Society," in *The Emergence of Science in Western Europe*, ed. Maurice Crosland (New York, 1976), pp. 57–78.

29. Joseph Glanvill, *Scepsis Scientifica* (London, 1665), Address to the Royal Society.

30. *Letters and Poems in Honour of the Incomparable Princess, Margaret, Duchess of Newcastle* (London, 1676), p. 124.

31. Joseph Glanvill, *The Vanity of Dogmatizing* (London, 1661), p. 189; Glanvill, "Against Confidence in Philosophy and Matters of Speculation," *Essays on Several Important Subjects in Philosophy and Religion* (London, 1676), p. 15; Glanvill, "Modern Improvements of Useful Knowledge," *Essays*, pp. 48–49; Glanvill, *Plus Ultra* (London, 1668), pp. 81, 89; Glanvill, "Against Confidence," *Essays*, p. 15. See Henry Van Leeuwen, *The Problem of Certainty in English Thought, 1630–1680* (The Hague, 1963), pp. 71–89; Jackson I. Cope, *Joseph Glanvill, Anglican Apologist* (St. Louis, 1956).

32. See Pierre Duhem, *To Save the Phenomena: An Essay on the Idea of Physical Theory from Plato to Galileo* (Chicago, 1969); Grant, "Hypotheses"; Blake, "Theories of Hypothesis"; Robert Westman, "Kepler's Theory of Hypothesis and the Realist Dilemma," *Studies in the History and Philosophy of Science* 3 (1972), 233–264. Hypotheses themselves were not novel in the seventeenth century, and astronomers frequently employed mathematical suppositions about the heavens. Because it was not considered necessary to assert that such hypotheses conformed to physical phenomena, they coexisted with Aristotelian physics.

33. Henry Power, *Experimental Philosophy . . . With some Deductions, and Probable Hypotheses raised from them* (London, 1664), preface. See also pp. 72, 192, 193. See also Power to William Croone, Royal Society Letter Book I, fol. 35; Thomas Birch, *The History of the Royal Society of London*, 4 vols. (London, 1756), I, 81, 165; George Garden, "A Discourse concerning the Modern Theory of Generation," in *Miscellanea Curiosa*, I, 142–152; "A Short Discourse concerning Concoction," ibid., pp. 153, 169.

34. Ralph Bohun, *A Discourse Concerning the Origine and Properties of Wind* (Oxford, 1671), preface; Robert Plot, *The Natural History of Oxfordshire* (London, 1675), 1704 ed., pp. 28, 43, 169; Oldenburg, *Correspondence*, VIII, 120. "A Theory might be established in the philosophical world, which might agree as much as possible with Observations and Experiments, which should be often repeated with due Care and Fidelity." *Philosophical Transactions*, 3 vols., 5th ed. (London, 1749), I, 461.

35. Samuel Parker, *A Free and Impartial Censure of the Platonicke Philosophie* (Oxford, 1666), pp. 44–45, 46–47; Sprat, *History of the Royal Society*, p. 233.

36. John Evelyn, *Sylva* (London, 1664), Preface to the Reader; Walter Charleton, *Immortality of the Human Soul* (London, 1657), p. 116

37. Walter Charleton, *Natural History of the Passions* (London, 1674), p. 4.

38. Nehemiah Grew, *The Anatomy of Plants* [1682] (New York, 1965), pp. 7, 221. "Conjecture" was aided by analogy. Nehemiah Grew, *The Idea of a Phytological History Propounded* (London, 1673), p. 40.

39. Oldenburg, *Correspondence*, X, 209. See also VII, 346.

40. See E. Zilsel, "The Genesis of the Concept of Physical Law," *Philosophical Review* 51 (1942), 245–279; Francis Oakley, "Christian Theology and Newtonian Science: The Rise of the Concept of the Laws of Nature," *Church History* 30 (1961), 433–457; Jane Ruby, "The Origins of Scientific "'Law,'" *Journal of the History of Ideas* 47 (1986), 341–359; John Milton, "The Origin and Development of the Concept of the 'Laws of Nature,'" *Archives Européennes de Sociologie* 22 (1981), 173–195. Boyle occasionally used the expression "laws of nature," and several members of the Royal Society spoke of the "laws of motion." Milton suggests that Hooke was the first to describe an empirically determined regularity of their own discovery as "a law or rule of nature." Nature was treated as being governed by laws long before there were attempts to state any laws, and theological voluntarism played a significant role. For Hooke, philosophical inquiry was a means of "finding out the ways and Means Nature use, and the Laws by which she is restrain'd in producing divers Effects." See Robert Hooke, *Micrographia* (London, 1665), preface; Hooke, *Posthumous Works*, ed. Richard Waller (London, 1705), p. 26. Margaret Osler suggests that the language of the laws of nature goes back at least to Lucretius and was often used by medieval philosophers. She suggests that what was new in the seventeenth century was the identification of particular propositions as laws of nature (personal communication). See also Benjamin Milner, "Francis Bacon: The Theological Foundations of the Valerius Terminus," *Journal of the History of Ideas* 58 (1997), 255–256; *Laws of Nature: Essays on the Philosophical and Historical Dimensions*, ed. Friedel Weinert (Berlin, 1995).

41. Royal Society, Letter Book, I, fol. 37, 63. See also fol. 42–46; Stephen Rigaud, *Correspondence of Scientific Men of the Seventeenth Century*, 2 vols. (Oxford, 1841), I, 94; Christian Huygens, *The Celestial Worlds Discovered* (London, 1968), p. 10; Aant Elzinga, "Huygens' Theory of Research and Descartes' Theory of Knowledge," *Zeitschrift fur Allegemeine Wissenschaft* 3 (1972), 17, 19. See also pp. 16–22; part I (1971), 174–194.
42. Neile manuscript quoted in Hunter and Wood, "Towards Solomon's House," pp. 79, 80. Experiments alone were "but a dry entertainment without the indagation of causes." Ibid., p. 53. Neile criticized Christopher Wren for his reluctance to "explain his principles" and find "a reason for his experiments" on motion.
43. Quoted in Hunter and Wood, "Toward Solomon's House," p. 59; William Petty, *Political Arithmetic* (London, 1690), preface. See also John Henry, "The Scientific Revolution in England," in *The Scientific Revolution in National Context*, ed. Roy Porter and Mikulas Teich (Cambridge, 1992), pp. 178–209.
44. If Moray suggested that "promiscuous" experiments be replaced by a "continued series," another member felt no observations or experiments "if truly made" should be "slighted." Quoted in Hunter, "Early Royal Society," pp. 197, 193. Still another suggested that the society examine all "Systems, Theories, Principles, Hypotheses, . . . and experiments," ancient and modern, in order to compile "A Complete System of Solide Philosophy, for explicating all phenomenon" and "rendring a rationall account of the causes of things." Until that time the Society was not to "own any hypothesis, system or doctrine in principles of Natural Philosophy, nor the explication of any phaenomenon. . . . Nor dogmatically define, nor fixe Axiomes of Scientificall things . . . adhering to none, till by mature debate & clear arguments, chiefly such as are deduced from legitimate experiments, the truth of such positions be demonstrated invincibly. . . . And till then be a sufficient collection made, of Experiments, Histories & observations, there are no debates to be held . . . concerning any Hypothesis or principle of philosophy, nor any discourse made for explicating any phenomena, except by special appointment of the Society, or allowance of the president." Although this statement has been traditionally attributed to Hooke, Hunter and Wood suggest that Moray is its author. "Towards Solomon's House," p. 81.
45. Hooke to Brouncker, quoted in F. F. Centore, *Robert Hooke's Contribution to Mechanics: A Study in Seventeenth-Century Natural Philosophy* (The Hague, 1970), p. 8.
46. Oldroyd, "Some Writings of Robert Hooke," pp. 157–158.
47. Hooke, *Posthumous Works*, pp. 393, 417; Birch, *History of the Royal Society*, I, 128–130, 175.
48. Hooke, *Posthumous Works*, p. 280.
49. Hooke, Royal Society Classified Papers, fols. 92–94, quoted in Hunter and Wood, "Towards Solomon's House," p. 90.
50. Hooke, *Micrographia*, preface. For Hooke's methodology, see Hunter and Schaffer, *Robert Hooke: New Studies*; D. R. Oldroyd, "Robert Hooke's Methodology of Science as Exemplified in His Discourse of Earthquakes," *British Journal for the History of Science*, 6 (1972), 110–130; Margaret 'Espinasse, *Robert Hooke* (Berkeley, 1962), pp. 28–33.
51. Quoted in Hunter and Wood, "Towards Solomon's House," p. 79.
52. Hooke, *Micrographia*, preface. About 1668 Hooke wrote that though the Royal Society "have hitherto seem'd to avoid and prohibit preconceived Theories and Deductions from particular, and seemingly accidental Experiments; yet I humbly conceive, that such, if knowingly and judiciously made, are Matters of the greatest Importance, as giving a Characteristick of the Aim, Use, and Significancy thereof, and without which man, and possibly the most considerable Particulars, are passed over without Regard and Observation." Quoted in Drake, *Restless Genius*, p. 160. The Royal Society, prior to the publication of *Micrographia*, emphasized that though they had licensed his work, "yet they own no theory, nor will they be thought to do so; and that several hypotheses and theories laid down by him therein, are not delivered as certainties, but as conjectures." They were not to be presented "to the world as the opinion of the Society." Nov. 23, 1664, Birch, *History*, I, 491.
53. Quoted in Robert Gunther, *Early Science in Oxford*, 15 vols. (Oxford, 1930), VI, 112.
54. An example was his own hypothesis on "animal Motion," which "no Man ever did or will

be able to explicate either this or other Phenomenon in Nature's true way and Method." *Philosophical Collections* (London, 1682), no. 2, 25.
55. Hooke, "Cometa," in *Lectiones Cutlerianae* (London, 1679), pp. 24–25, 53, 34.
56. Quoted in Bennett, "Hooke and Wren," p. 43. See also pp. 35–37. "Probable arguments" were appropriate to the Copernican and Tychonic hypotheses because there could never be determination of the controversies "without some positive observations from determining whether there were a Parallax or no of the Orbs of the Earth." Robert Hooke, *An Attempt to Prove the Motion of the Earth from Observations* (London, 1674), p. 4.
57. For Hooke's natural philosophy, see Oldroyd, "Hooke's Methodology of Science," pp. 109–130; D. R. Oldroyd, "Some Writings of Robert Hooke on Procedures for the Prosecution of Scientific Enquiry, including his 'Lectures of Things Requisite to a Natural History,'" *Notes and Records of the Royal Society of London* 41 (1987), 145–167; J. A. Bennett, "Robert Hooke as Mechanic and Natural Philosopher," *Notes and Records of the Royal Society of London* 35 (1980), 33–47. See also Lotte Mulligan, "Robert Hooke and Certain Knowledge," *Seventeenth Century* 7 (1992), 151–169; Hunter and Schaffer, *Robert Hooke: New Studies*.
58. Hooke, *Posthumous Works*, p. 3.
59. Robert Boyle, "Excellency of Theology," *The Works of the Honourable Robert Boyle*, ed. Thomas Birch, 6 vols. (London, 1772), IV, 59. "Things discovered in after times" might "overthrow doctrine" based on current observations.
60. Robert Boyle, "Certain Physiological Essays," *Works*, I, 303, 311.
61. Ibid., pp. 302, 303. See also Robert Boyle, *Hydrostatical Paradoxes* (London, 1666), preface; Boyle, "The Experimental History of Colors" (1664), *Works*, I, 662; Boyle, *A Defense of the Doctrine Touching the Spring of Air* (London, 1662), preface. See Richard Westfall, "Unpublished Boyle Papers Related to Scientific Method," *Annals of Science* 12 (1956), 63–73; Frederick J. O. Toole, "Robert Boyle's Concept of Science and Nature" (unpublished paper). M. B. Hall suggests that Boyle may have changed his views of hypothesis, initially feeling that his experiments "illustrated" the corpuscular philosophy and later claiming that they could prove it. Hall, "Science in the Early Royal Society," in *The Emergence of Science in Western Europe*, ed. Maurice Crosland (New York, 1976), p. 73. For Sargent, Boyle's "facts" occasionally involved statements about regularly occurring events and causes rather than particular events. The spring of air, which Boyle initially treated as hypothetical, therefore became "factual." Rose-Mary Sargent, *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment* (Chicago, 1995), pp. 132, 134, 136. See also Jan Wojcik, *Robert Boyle and the Limits of Reason* (Cambridge, 1997), pp. 161–180.
62. Robert Boyle, *An Essay about the Origen and Nature of Gems* (London, 1672), preface, p. 123.
63. See *Philosophical Transactions* I (1665–66), 192.
64. Boyle, "Origine of Particular Qualities," *Works*, IV, 347.
65. Boyle, "Some Considerations touching the Usefulness of Experimental Natural Philosophy," *Works*, II, 45. The same effect might be produced by different causes. Ibid. Boyle also wrote "Of the Excellency and Grounds of the Mechanical Hypothesis."
66. Westfall, "Unpublished Boyle Papers," pp. 63–73. See also Boyle, "Of the Excellency and Grounds of the Corpuscular Hypothesis," *Works*, IV, 68–78; *Works*, I, 30; Marie Boas Hall, *Robert Boyle on Natural Philosophy* (Bloomington, Ind., 1965), pp. 134–135; Marie Boas, "Boyle as a Theoretical Scientist," *Isis* 46 (1950), 261–268.
67. Boyle, "Certain Physiological Essays," *Works*, I, 302. See also Boyle, *Works*, III, 739–740.
68. Boyle, *Hydrostatical Paradoxes*, preface.
69. Boyle, *Works*, IV, 182.
70. Robert Boyle, "The Christian Virtuoso," *Works*, V, 339–340.
71. Boyle, *Hydrostatical Paradoxes*, preface. See also Oldenburg, *Correspondence*, III, 160–161; Boyle, *Works*, II, 125. "Doctrine" and "theory" were occasionally used interchangeably. See "An Introductory Essay to the Doctrine of Sounds" (1683), in Derham, *Miscellanea Curiosa*, I, 121.
72. Boyle, "Certain Physiological Essays," *Works*, I, 303. In connection with his "theorie and

conjectures concerning the mechanical production of qualities," Boyle insisted he did not "debar himself of the liberty either of altering them or substituting others" if "progress in the history of qualities shall suggest better hypotheses or explications." *Works*, IV, 236. See also "Experiments and Considerations Touching Colours," *Works*, I, 688, 695.

73. Boyle, *Works*, IV, 462.

74. See Margaret J. Olser, "The Intellectual Sources of Robert Boyle's Philosophy of Nature: Gassendi's Volunteerism and Boyle's Physico-Theological Project," in *Philosophy, Science, and Religion in England, 1640–1700*, ed. Richard Kroll, Richard Ashcraft, and Perez Zagorin (Cambridge, 1992), pp. 178–198; Shapiro, *Probability and Certainty*; Van Leeuwen, *Problem of Certainty*; J. J. MacIntosh, "Robert Boyle's Epistemology: The Interaction between Science and Religious Knowledge," *International Studies in the Philosophy of Science* 6 (1992), 91–122. Sargent rejects the probabilistic assessment and the characterization of Boyle as an empiricist. *Diffident Naturalist*, pp. 104, 210, 211.

75. Oldenburg, *Correspondence*, II, 170; IX, 20, 307.

76. *Philosophical Transactions* I (1665–66), 192, 193, 263, 264, 265, 266, 271, 281–282, 288; III (1668), 652; Oldenburg, *Correspondence*, III, 136, 148, 154, 159, 277, 346. Oldenburg also referred to the "hypothesis" of the tides. Ibid., III, 8.

77. Oldenburg, *Correspondence*, VII, 103, 563–564. See also VIII, 26, 72–74, 79. Oldenburg replied to Leibniz that matters lying outside the rigor of mathematics typically resulted in a variety of opinions. Ibid., VII, 103.

78. See William A. Wallace, "Galileo and Reasoning ex suppositione," in Wallace, *Prelude to Galileo* (Dordrecht, 1981); Margaret Morrison, "Hypothesis and Certainty in Cartesian Science," in *An Intimate Relation . . . Studies Presented to Robert E. Butts*, ed. James R. Brown and Jurgen Mittelstrass (Dordrecht, 1989).

79. See Dear, *Discipline and Experience*.

80. Oldenburg, *Correspondence*, IX, 27–28, 149.

81. *Isaac Newton's Papers and Letters on Natural Philosophy*, ed. I. B. Cohen (Cambridge, Mass., 1958), pp. 2, 106. Peter Dear suggests that Newton's work on colors was typical of the geometrical optics, which sought universal propositions, and although Newton used reasoning and experience to support these truths, they were not part of the proof itself. Newton was not attempting to use "facts" to support a still hypothetical generalization but aimed at universal statements derived from mathematical natural philosophy and experiment. *Discipline and Experience*, p. 232. See also Zev Bechler, "Newton's Optical Controversies: A Study in the Grammar of Scientific Dissent," in *The Interaction between Science and Philosophy*, ed. Y. Elkana (Jerusalem, 1974), pp. 118–119, 122–124, 129–134; Richard S. Westfall, "The Foundation of Newton's Theory of Colours," *Isis* 53 (1962), 339–358.

82. Oldenburg, *Correspondence*, IX, 119, 249; "un hypotheses fort vraisemblable." Ibid., IX, 247. See also ibid., IX, 383, 555.

83. Oldenburg, *Correspondence*, IX, 16–17; IX, 109. Flamsteed referred to it as a theory. Pardies denied he had called Newton's theory a hypothesis out of contempt. Ibid., IX, 63, 119.

84. Rigaud, *Correspondence of Scientific Men*, II, 390. Gregory to Collins, April 1672. See also Hall, "Science in the Early Royal Society," pp. 69–71.

85. Some translators render this, "I frame no hypotheses"; others, "I feign no hypotheses."

86. Isaac Newton, *Mathematical Principles of Natural Philosophy*, ed. F. Cajori (Berkeley, 1934), pp. 546, 547. I. B. Cohen traces the evolution of Newton's views on hypothesis in succeeding editions of *Principia*. "Hypotheses in Newton's Philosophy," in *Seventeenth-Century Natural Scientists*, ed. Vere Chappell, 12 vols. (New York, 1992), VII, 206–236; François Duchesneau, "The 'More Geometrico' Pattern in Hypotheses from Descartes to Leibniz," in *Nature Mathematized*, ed. William R. Shea (Dordrecht, 1983), pp. 197–214; Anita M. Pampusch, "'Experimental,' 'Metaphysical,' and 'Hypothetical' Philosophy in Newtonian Methodology," *Centaurus* 18 (1974), 289–300.

87. Ephraim Chambers, *Cyclopaedia or An Universal Dictionary of the Arts and Sciences*, 4 vols. (London, 1727). Science included "things as men may discover by the use of sense and reasoning," such as the laws of nature. I, ix. In the "Experimental Philosophy" the "laws of na-

ture and the Properties and Powers of Bodies" were deduced from "sensible experiments and observations." I, 281.
88. John Locke, *On Education*, ed. Peter Gay (New York, 1964), p. 160. See also G. A. J. Rogers, "Locke's *Essay* and Newton's *Principia*," *Journal of the History of Ideas* 39 (1978), 217–232.
89. John Keill, *An Examination of Dr. Burnet's Theory of the Earth* (Oxford, 1698), p. 22. See also Halley's review of the *Principia* in Cohen, *Newton's Papers and Letters*, pp. 405–424.
90. Richard Sorrenson, "Towards a History of the Royal Society in the Eighteenth Century," *Notes and Records of the Royal Society* 50 (1996), 29–46. Sorrenson rejects the view of Society decline. Hans Sloane, *A Voyage to the Islands . . . with the Natural History* (1701), quoted in Harold Cook, "The Cutting Edge of a Revolution? Medicine and Natural History near the Shores of the North Sea," in *Renaissance and Revolution: Humanists, Scholars, Craftsmen, and Natural Philosophers in Early Modern Europe*, ed. J. V. Field and Frank James (Cambridge, 1993), p. 49. See also Charles Leigh, *Natural History of Lancashire* (Oxford, 1700), pp. 35, 48, 100–101, 106.
91. Cook, "Cutting Edge," p. 46, quoting *Philosophical Transactions* L (1757), 461.
92. Sorrenson, "Towards a History of the Royal Society," pp. 39–41.
93. Woodward, *Natural History of the Earth*, pp. 73–74.
94. Ibid., pp. xii, xiii. He was not yet ready to offer "a complete Theory" (p. xii). No conjecture would "abide the Test; because they have not due warrant from Observation" and are "repugnant thereunto." Ibid., p. 40.
95. Woodward, *An Attempt Towards a Natural History of Fossils*, 2 vols. (London, 1726), I, xiv. His *Fossils of all Kinds, digested into a Method* (London, 1728), addressed to Newton, claimed that his "Method," if not Newton's own, "is wholly owing to you; it being begun, carried on, and finished at your Request" (pp. 1–2).
96. For Matthew Hale, "the Laws of Nature are stable, and sealed and regular, and not like the Laws of Men," which are changeable. *Difficiles Nugae: Or, Observations Touching the Torricellian Experiment* (London, 1674), pp. 6–7.
97. Chambers, *Cyclopaedia*, I, 281.
98. Oliver Goldsmith, *A Survey of Experimental Philosophy*, 2 vols. (London, 1776), Advertisement to the Reader, I, 4, 6. Cartesian natural philosophy is characterized as a "romance." Ibid., I, 13.
99. "Fact" for Chambers was something actually done or "done indeed." *The Royal English Dictionary*, ed. D. Fenning (London, 1761), in addition to defining fact a "thing done," refers to it as "A Reality, opposed to meer supposition or speculation." The purpose of experiments is to "discover their effects, their laws, and relations, or to be able to arrive at the true cause of phaenomenon occasioned thereby." Samuel Johnson's *Dictionary of the English Language*, 4 vols., 2d ed. (London, 1755), also defined "fact" as "Reality; not supposition; not speculation." John Kersey, *Dictionarium Anglo-Britannicum* (London, 1708), retains traditional legal usage. Fact "is a Truth that may be prov'd tho not by Record, and Matter of Record is that which is prov'd by some Record." See also N. Bailey, *A Universal Etymological English Dictionary* (London, 1721).
100. Harvey Wheeler, "Science out of Law: Francis Bacon's Invention of Scientific Empiricism," in *Towards a Humanistic Science of Politics*, ed. F. D. Nelson and R. L. Sklar (London, 1983), pp. 101–143; Rose-Mary Sargent, "Scientific Experiment and Legal Expertise: The Way of Experience in Seventeenth-Century England," *Studies in the History and Philosophy of Science* 20 (1989), 19–45. Sargent argues that Boyle's natural philosophy followed legal methods for deriving legal principles. *Diffident Naturalist*, pp. 42–50. Legal emphasis on moral certainty, however, was centered on the individual "facts" rather than the "law" or legal principles.
101. Hale, *Difficiles Nugae*, p. 6.
102. Literary scholars first explored the role of English science in modifying English prose style in the direction of greater "plainness." R. F. Jones argued that the "new philosophy" played a substantial role in the seventeenth-century critique of highly ornamented and rhe-

torically sophisticated prose and poetry. R. F. Jones, *The Seventeenth Century: Studies in the History of English Thought and Literature from Bacon to Pope* (Stanford, 1951). But see Brian Vickers and Nancy Streuver, *Rhetoric and the Pursuit of Truth: Language Change in the Seventeenth and Eighteenth Centuries* (Los Angeles, 1985); Richard Kroll, *The Material Word* (Baltimore, 1991); Robert E. Stillman, "Assessing the Revolution: Ideology, Language, and Rhetoric in the New Philosophy of Early Modern England," *Eighteenth Century* 35 (1994), 99–118. The contributions of latitudinarianism, humanist academies, and the ideology of courtly and gentlemanly behavior have also been invoked in connection with the linguistic norms of the virtuosi. The "polite," however, often ridiculed the virtuosi. See Lawrence Klein, *Shaftesbury and the Culture of Politeness: Moral Discourse and Cultural Politics in Early-Eighteenth-Century England* (Cambridge, 1994).

103. See also Sir Philip Sidney, *An Apology for Poetry* [1595], ed. Forrest G. Robinson (New York, 1970). Richard Blome separated style from logic. *The Gentleman's Recreations . . . being the Enclycopedy of the Arts and Sciences* (London, 1686). But Chambers's *Cyclopaedia* defined rhetoric as the means of persuasion and included invention, amplification, argument, narration, and style.

104. Sprat, *History of the Royal Society*, p. 112. Bacon insisted that the study of nature required the rejection of "pugnatious disputations" and "probable oratory." *The Works of Francis Bacon*, ed. James Spedding, Robert Leslie Ellis, and Douglas Denon Heath, 14 vols. (London, 1857–74), III, 636.

105. Sprat, *History of the Royal Society*, pp. 62, 111, 113. "Who can behold, without indignation, how many mists and uncertainties, these specious Tropes and Figures have brought on our Knowledge. How many rewards . . . have been . . . snatch'd away by the vanity of fine speaking." Ibid., p. 112. Sprat, who was hired by the Royal Society for his rhetorical skill, also promoted an "impartial Court of Eloquence" akin to the French Academy.

106. Weld, *History of the Royal Society*, II, 527.

107. Hooke, *Posthumous Works*, p. 63.

108. See Shapiro, *Probability and Certainty*, pp. 227–256. Natural history was to be recorded without embellishment and would set "forth a simple narrative of the facts . . . to be described with perspicuity." Bacon, *Works*, V, 510–511. See also Hooke, *Micrographia*, preface; John Ray, *The Ornithology of Francis Willughby* (London, 1678), preface. Stylistic pronouncements did not always result in a plain style. Boyle's prose was complex and convoluted.

109. See Dear, "Totius in verba," pp. 145–161. The unembellished first-person account was preferred but not always practiced. Dear shows that compilers sometimes compressed firsthand reports into summaries and that portions of reports dealing with the setting up of experiments were often written in the passive voice.

110. *The Royal English Dictionary* (London, 1761) defined narrative as "giving an account of fact or a series of facts as they happened."

111. *Philosophical Transactions* V (1670), 1152–1153; P. B. Wood, "Methodology and Apologetic: Thomas Sprat's History of the Royal Society," *British Journal for the History of Science* 13 (1980), 1–24.

112. Hooke, *Micrographia*, preface; Oldenburg, *Correspondence*, VIII, 51, 74, 324. Samuel Sorbière associated the Society's moderate mode of discourse with hypothesis. *A Voyage to England* (London, 1709), p. 38.

113. Oldenburg condemned "Arguing and disputing." *Philosophical Transactions* II (1667), 503–504. Boyle thought the natural philosophy of the schools "litigious" and "barren." *Some Considerations Touching the Usefulnesse of Experimentall Naturall Philosophy* (Oxford, 1663), pp. 2–3. Locke attacked the competitiveness and wrangling of the disputation, where "victory" was "adjudged not to him who had Truth . . . but the last word in the Dispute." John Locke, *Essay Concerning Human Understanding* (London, 1690), III, x, 7. See also IV, vii, 11; Peter Walmsley, "Dispute and Conversation: Probability and the Rhetoric of Natural Philosophy in Locke's *Essay*," *Journal of the History of Ideas* 54 (1993), 381–394.

Members of the Royal Society whose professional lives shifted back and forth between London and the universities—e.g., Wilkins, Wallis, Goddard, Barrow, Wren, Willis, and New-

ton—should be characterized as both Society members and university-oriented intellectuals. Humanist scholars often used the dialogue, a genre that could be employed either contentiously or politely. The legal advocate's necessarily partisan mode of argumentation and the winner-loser model of the courts were also rejected. But see Shapin and Schaffer, *Leviathan and the Air Pump*; Shapin, *Social History of Truth*; Lorraine Daston, "Baconian Facts, Academic Civility, and the Prehistory of Objectivity," *Annals of Scholarship* 9 (1991), 337–363; Mario Biagoli, "Etiquette, Interdependence, and Sociability in Seventeenth-Century Science," *Critical Inquiry* 22 (1996), 193–238.

114. See Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley, 1995); Mario Biagoli, *Galileo Courtier: The Practice of Science in the Culture of Absolutism* (Chicago, 1993). No precedence was permitted in the Royal Society except for the president, secretary, and distinguished visitors.

115. Baldasar Castiglioni, *The Book of the Courtier*, trans. Charles S. Singleton (Garden City, N.Y., 1959), p. 294.

116. See Daniel Javitch, *Poetry and Courtliness in Renaissance England* (Princeton, 1978); Royal Society, Original Letters, fol. 214, Sept. 21, 1664.

117. See Anne Goldgar, *Impolite Learning: Conduct and Community in the Republic of Letters, 1680–1750* (Cambridge, Mass., 1995); *Commercium Litterarium: Forms of Communication in the Republic of Letters, 1600–1650*, ed. H. Bot and F. Waquet (Amsterdam, 1994); Lorraine Daston, "The Ideal and Reality of the Republic of Letters in the Enlightenment," *Science in Context* 4 (1991), 367–386; H. Bot and F. Waquet, *La republique des lettres* (Paris, 1997).

118. Exclusion did not mean that participants were uninterested or uninvolved with religious issues or that philosophical topics did not have important religious implications.

119. Barbara Shapiro, "Latitudinarianism and Science in Seventeenth-Century England," *Past and Present* 48 (1968), rpt. in *The Intellectual Revolution of the Seventeenth Century*, ed. Charles Webster (Oxford, 1974), pp. 286–316.

120. See ibid.; Shapiro, *Probability and Certainty*.

121. Glanvill, *Plus Ultra*, p. 149. The virtuoso possessed "a sense of his own fallibility . . . and never concludes but upon resolution to alter his mind upon contrary evidence. Thus he conceives warily and he speaks with . . . caution . . . and with great deference to opposite persuasion, candour to dissenters, and calmness in contradictions, . . . he gives his reasons without passion . . . discourses without wrangling, and differs without dividing. . . . He suspends his judgment when he does not clearly understand." Ibid., p. 147. An "open inquiry in the great Field of Nature" led men to "more indifferency toward those petty Notions, in which they were before apt to place a great deal of Religion; and to reckon that [it] lies, in the few, certain, operative Principles of the Gospel, . . . and not . . . upon Questions that engender strife." Joseph Glanvill, *Essays on Several Important Subjects* (London, 1676), essay IV, p. 27. The natural philosopher must "proceed with wariness and circumspection without too much forwardness in establishing maxims and positive doctrines; to propose their opinions as hypotheses that may probably be the true account; without peremptory affirming that they are." The "principal rule" was "to be wary and diffident, not to be hasty in our conclusions, or overconfident of opinions; but to be sparing of our assent and not to afford it but to things clearly and distinctly perceived." Ibid., p. 51.

122. Sprat, *History of the Royal Society*, p. 53; John Wilkins, *Sermons Preached on Several Occasions* (London, 1682), p. 414.

123. Oldenburg emphasized the "great difference between a regulated, unprejudiced mind, and those who speak about everything with a decisive air, and wish to have their ideas pass for . . . demonstrations." *Correspondence*, X, 22. The Royal Society laid "aside all set Speeches and Eloquent Harangues as fit to be banisht out of all Civil Assemblies, as a thing found by woeful experience, especially in England, fatal to Peace and good Manners." Edward Chamberlayne, *Anglia notitia: or, The Present State of England* (London, 1673), p. 345.

124. Sprat, *History of the Royal Society*, pp. 32–34. See also p. 341.

125. Klein questions the notion of "polite science." *Shaftesbury and the Culture of Politeness*;

Lawrence Klein, "Enlightenment as Conversation" (unpublished paper). Addison as well as Shaftesbury dismissed natural science as irrelevant to the culture of politeness.

Chapter 7: Facts of Religion

1. See Barbara J. Shapiro, *Probability and Certainty in Seventeenth-Century England: The Relationships between Religion, Natural Science, Law, History, and Literature* (Princeton, 1983); Henry Van Leeuwen, *The Problem of Certainty in Seventeenth-Century England, 1630–1690* (The Hague, 1963); Gerard Reedy, *The Bible and Reason: Anglicans and Scripture in Late-Seventeenth-Century England* (Philadelphia, 1985).
2. Hugo Grotius, *The Truth of the Christian Religion*, ed. Simon Patrick (London, 1680), p. 21. The Resurrection and Christ's miracles, questions of "Matter of Fact," were confirmed "by unexceptionable Testimonies." Ibid.
3. William Chillingworth, *The Religion of Protestants: a Safe way to Salvation*, 2d ed. (London, 1638), pp. 57, 88, 115. See also Robert Orr, *Reason and Authority: The Thought of William Chillingworth* (Oxford, 1967); Van Leeuwen, *Problem of Certainty*.
4. Seth Ward, *A Philosophical Essay Toward the Eviction . . . of God* [1654], 4th ed. (London, 1677), pp. 84–88.
5. Ibid., pp. 99–101, 102, 107 ff., 117.
6. London, 1662, preface, pp. 120–136. See also Edward Stillingfleet, *A Rational Account of the Grounds of Protestant Religion* (London, 1664); Robert Carroll, *The Common Sense Philosophy of Religion of Bishop Edward Stillingfleet, 1635–1699* (The Hague, 1975). The word "martyr" has its origin in the Greek root meaning "witness."
7. Edward Stillingfleet, *Origines Sacrae* (London, 1662), p. 285. See also Thomas Sprat, *History of the Royal Society*, ed. Jackson Cope and H. W. Jones (St. Louis, 1958), pp. 362–363.
8. Stillingfleet, *Origines Sacrae*, p. 286.
9. Ibid., pp. 260, 287–288.
10. Ibid., p. 297.
11. Stillingfleet condemned "pedantic flourishes, flattering insinuations," and "affected cadences." Ibid., pp. 199, 293, 295.
12. John Tillotson, *The Rule of Faith* (London, 1666), pp. 85, 102, 118. "Matters of Fact" were proved by "credible Testimony." One can have "an undoubted assurance of them, when . . . prov'd by the best Arguments that the nature and quality of the thing will bear." Tillotson, *The Works* (London, 1696), preface. For Locke, see John Marshall, *Resistance, Religion, and Responsibility* (Cambridge, 1994), p. 128. See also Thomas Smith, *Sermon of the Credibility of the Mysteries of the Christian Religion* (London, 1675), p. 25; Jan Wojcik, *Robert Boyle and the Limits of Reason* (Cambridge, 1997).
13. John Wilkins, *The Principles and Duties of Natural Religion* (London, 1675), pp. 9–10. See also Charles Wolseley, *The Reasonableness of Scripture Belief* (London, 1672); John Evelyn, *The History of Religion* (London, 1850), p. 393. See also p. 392.
14. Robert Boyle, *Some Considerations about the Reconcileableness of Reason and Religion* (London, 1675), pp. 93, 95, 96.
15. Boyle, "Reconcileableness of Reason and Religion," *The Works of the Honourable Robert Boyle*, ed. Thomas Birch, 6 vols. (London, 1772), IV, 182. See also "A Discourse of Things Above Reason," *Works*, IV, 449.
16. Robert Boyle, "The Christian Virtuoso," *Works*, VI, 525.
17. "Since we scruple not to be believe such Prodigies, as Celestial Comets, Vanishing and Reappearing Stars . . . and like amazing Anomalies of Nature, upon the credit of Human Histories; I see not that Vicarious Experience should not be more trusted, which has divers peculiarly current Circumstances to Confirm it." *The Christian Virtuoso* (London, 1690), p. 81. See also R. M. Burns, *The Great Debate on Miracles from Joseph Glanvill to David Hume* (London, 1981), pp. 51–54.
18. Robert Boyle, *Reasons Why a Protestant should not turn Papist* (London, 1687), p. 17.